ABSTRACT

This report describes the present market penetration of substitutes and synthetics available for food and beverages and for apparel and furnishings. Synthetics and substitutes have captured about 21 percent of retail citrus beverage purchases; margarine has more than two-thirds of the table spread market; and other foods and beverages, including whipping cream and sweeteners have lost sales to new products. Nearly half of all broadwoven goods are made from synthetic fibers or a blend containing synthetic and natural fibers. At least two levels of market penetration by synthetics and substitutes are projected for 1980 for red meat and poultry, dairy products, leather, wool, cotton, sweeteners, and citrus products. Changes in land resources are shown for each projected level of market penetration. Agriculture is expected to maintain its position as a major supplier of our food and fiber needs in 1980. Synthetics are not expected to cause major adjustment problems for agriculture through the 70's.

Keywords: substitutes, synthetics, projections 1980, resource allocation, animal products, cotton, sweeteners, citrus

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HIGHLIGHTS

Although synthetics and substitutes will not cause major adjustment problems for agriculture in the seventies, they continue to replace many traditional foods and beverages. Synthetics or substitutes have captured about 21 percent of retail citrus beverage purchases; margarine has more than two-thirds of the table spread market, and other foods and beverages, including whipping cream and sweeteners, have lost sales to new products.

Substitution of more vegetable protein for animal products probably will generate great interest and far-reaching changes in foods over the next 10 years. Foods fabricated from vegetable protein to replace meat and dairy products are not new, but advancements in technology and processing will make them more like meat and dairy products in texture, flavor, and nutritional characteristics.

Natural fiber used in apparel and house furnishings have long faced competition from synthetic products. Nearly half of all broadwoven goods are made from synthetic fibers or blends containing synthetic and natural fibers. Fine-woven cotton goods have been more susceptible to market loss to synthetics than have coarse broadwovens. Fine cotton fabrics have lost to synthetics in the apparel market, where fabric price is not as critical as with coarse-woven fabrics. Since 1967, manmade fibers have surpassed wool as the major fiber processed in woolen mills.

Leather has also suffered from competition by synthetics. Shoe manufacturing uses slightly more than 50 percent of our cowhides, but the percentage of shoes with leather soles and uppers has declined. By 1969, only 69 percent had leather uppers, while 15 percent had leather soles.

Agriculture provides basic raw materials for adhesives, paints, paper, detergents, textiles, gypsum board, and many other industrial products. Synthetics have been especially strong in displacing starch in the adhesive market. Use of linseed and soybean oil, major drying agents used in paints, has steadily decreased in the last two decades as synthetics have eroded this market. Synthetic detergents now account for a major share of the soap market, reducing one of the largest industrial uses for fats and oils.

Two or more levels of market penetration by substitutes and synthetics were projected to 1980, each level involves different assumptions for selected animals and crops. The first significant market penetration in red meat and poultry by vegetable proteins probably will be as extenders in institutional markets. At the highest level of market penetration projected, about 20 percent of the red meat would be replaced in processed

foods by vegetable proteins, amounting to about 8 percent of total red meat production. Market penetration would be minimal in poultry products even at the high level of replacement. Dairy products probably will continue to be replaced by substitutes and synthetics, and at the highest level of market penetration just over 9 percent of the projected 1980 market would be held by substitute and synthetic products.

Market penetration by synthetics for two other animal products, leather and wool, will increase. However, the total quantities of leather required will remain well below total hides available for leather. Total consumption of wool would decline at the highest level of market penetration by synthetics, but would remain above domestic production.

Cotton will continue to lose potential markets to synthetic fabrics although the rate of loss is decreasing. These fabrics are expected to have 55 to 65 percent of the broadwoven fabric market by 1980. However, population increases and reasonable assumptions on imports and market penetration by synthetics could mean cotton consumption of about 9 million bales, up somewhat from the current level.

The highest projected level of market penetration by substitutes for sugar should still give a per capita consumption of 98 pounds with a resulting slight increase in total consumption.

Per capita consumption of natural citrus beverages is expected to increase more than 30 percent by 1980, with a resulting increase in total consumption. Powdered synthetic orange drinks may increase their market shares slightly, but natural citrus drinks are expected to more than hold their own against other substitutes.

Loss of traditional outlets for animal products through market penetration by substitutes and synthetics would free some land and other resources no longer needed to produce animal products. Total net release of land resources through market penetration by substitutes and synthetics in 1980 for all animal products would be approximately 1½ million acres at the low level and 5 million at the high level. The 5 million acres represent about 1½ percent of the land presently used for crops. Substitution of vegetable protein for red meats in processed items would free the most acres and substitution for poultry products the fewest acres. Although there would be an impact on producers of livestock products, adjustments in production would probably be less than changes in the structure of soybean processing and allied industries.

Although the land resources freed would be relatively small, shifts of land to other uses such as recreational and leisure time activities could be expected. Reduction in animal numbers and land devoted to crops also implies a reduction in the need for

tractors, fertilizer, medicine, and other inputs used in agricultural production. Welfare of consumers, however, could increase with greater use of substitutes and synthetics, as these tend to have a moderating influence on prices or provide a product with more stabilized qualities.

SYNTHETICS AND SUBSTITUTES FOR AGRICULTURAL PRODUCTS: PROJECTIONS FOR 1980

By

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INTRODUCTION

In many countries, the food and fiber supply is not adequate to satisfy the needs of the population. In the United States, however, shortages of food and fiber are not expected since new materials and techniques are constantly being developed. In the past, improvements in production, processing, and marketing as well as opening of new lands have supplied U.S. food and fiber needs. Yet, we have increasingly turned to substitute products.

The search for substitutes has evolved and expanded with advancing levels of scientific and technical achievement. New breeds of livestock and plants have substantially altered our supply of food and fiber. Development of different processing techniques further extended the possibilities for substitution. Canning introduced a new form of food that could be substituted for fresh or dried products. More recently, new processing methods have contributed to a substantial substitution of vegetable fats and oils for animal fats. Widespread use of household refrigeration paved the way for the substitution of frozen foods for both canned and fresh products. Techniques such as freeze drying and irradiation probably will continue to furnish new substitutes.

Synthesizing techniques are becoming an important part of the continuing search for new products. Raw materials may come from plants and animals, or from coal, petroleum, or other nonagricultural materials. Today, more ingredients for the growing assortment of synthesized substitutes are derived either from sources outside or within agriculture quite different from traditional ones. Also, many of these synthesized products use ingredients from several sources.

On the supply side, substitution growing out of a changing mix of primary agricultural products, or substitution of processed versions of these products, mostly influence the alinement of

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1/ MED subject specialists contributed as follows: Allen J. Baker, livestock products; Roy A. Ballinger, sweeteners; Kermit Bird, protein; John R. Brooker, citrus; Herbert H. Moede, dairy; and John E. Ross, cotton.

agricultural resources. In contrast, synthetic substitutes derived primarily from nonagricultural sources affect resource utilization both within and outside agriculture.

Objectives of this study are to: Show the extent that substitutes have replaced agricultural products; estimate two or more levels of market penetration by substitutes in markets for agricultural products in 1980; and analyze the impact of market penetration on resource use in agriculture and changes in marketing.

A general procedure was used to make the commodity projections. Two or more levels of market penetration by substitutes and synthetics were assumed for each commodity. The levels were based on historical data; different assumptions regarding relative prices, present and anticipated developments in technology; Government regulations and programs; and tastes and preferences of consumers. Whenever possible, market penetration by substitutes in each end use was combined to get an estimate of the total market penetration for a commodity. In most instances, levels of market penetration were converted to quantities and subtracted from demand projections for 1980 made by the Economic and Statistical Analysis Division (ESAD), ERS, USDA. 2/ In the original projections, especially dairy and citrus, use of substitutes was reflected in historical data used in making the projections. In the cotton projections, market penetration by synthetic fibers was explicitly taken into account. ESAD projections for red meat and poultry would reflect little penetration by substitute products since meat has faced little competition from substitutes in the past. Levels of market penetration in this study are in addition to those implied in the ESAD projections, except for dairy, citrus products, and sugar. These differences are noted in the appropriate sections. It is also possible that increased use of substitutes for some commodities would have an additive effect on the market. For example, increased use of vegetable protein as extenders in meat patties would lower the costs and possibly increase the total quantity of patties consumed. In this case, the total quantity of meat replaced by vegetable protein would be less than the quantity of vegetable protein used. Data are not available on the additive effect of these substitutes, thus substitutes and synthetics were assumed to replace rather than add to a market.

While the economics of supply and demand may be favorable to introduction of certain substitutes, constraints imposed by the institutional and legal environment can cloud the future of many

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2/ Culver, David W. and Chai, J. C., "A View of Food and Agriculture in 1980," Agricultural Economics Research. Vol. 22, No. 3, July 1970, and Statistical Appendix to "A View of Food and Agriculture in 1980."

such products. Labeling and standards of identity are major uncertainties for many fabricated items. Also, projections of the future growth of substitutes need to be tempered by knowledge that market shares of new products frequently fail to sustain a vigorous rate of growth. Typically, the growth rate is quite rapid in the initial stage, levels off, and later declines.

Not all agricultural commodities were covered in this report. Those included either had a history of product substitution or product development of substitutes and synthetics indicated a potential loss of market by natural products.

Areas were identified and delineated where synthetics and substitutes have made or are expected to make a significant impact on traditional agricultural markets. Then, penetration of traditional agricultural markets by synthetics and substitutes were projected to the year 1980 for selected products. The report also deals briefly with implications and impacts of market penetrations related to changes in agricultural resources.

MAIN AREAS OF SUBSTITUTION FOR AGRICULTURAL PRODUCTS

Because most of our food and much of our fiber and industrial inputs are derived from agricultural products, there are many possibilities for substituting one agricultural product for another and for completely replacing an agricultural product with a synthetic. The main areas of substitution are outlined below.

Food and Beverages

Food processors are tailoring many new foods to meet the changing needs of the market. Our food production system is continually producing foods or combinations of foods demanded in the marketplace and delivered at the lowest possible costs. Low production cost areas may be far from the market, and distance is a strong incentive to eliminate water, reduce inedible portions, and transform the foods into a less perishable form. Additives, packages, and processing techniques are used to maintain nutrition and freshness. These changes encourage blending and mixing of foods and putting them into ready-to-cook or ready-to-eat forms. The food-processing industry has attained a level of technical competence that allows new and different foods to come from nontraditional sources. Constant economic pressure for lower cost, greater utility, and convenience results in a marketing system using more substitutes.

Proteins

Nutritionally, proteins are essential to create and maintain body tissue, comprising over 40 percent of human body weight on a

water free basis. Unfortunately, protein deficiency is especially acute in developing countries of the world and is a problem among low-income groups in this country. Red meats and poultry supply about 41 percent of the protein consumed. Dairy foods and eggs provide another 25 percent. All animal products, including fish, supply roughly two-thirds of the protein; the remaining third comes from plants.

Protein ingredients are sometimes added to processed food products to improve their physical properties. For example, bakers utilize soy's water-retentive capacity to improve baked goods' freshness. Whipped dairy products may contain soy protein ingredients for use as stabilizers. Isolated soy proteins, designed with specific functional characteristics, may be substituted in some instances for nonfat dry milk. Even processed meats may have some vegetable protein ingredients added to bind meat particles together and retain natural juices. Recently, textured protein has been the base for various types of food analogs. Within a given group of protein alternatives, when the functional characteristics are similar, food processors will rely primarily on cost as a basis for selection.

A Cornell study concluded that there already exists a substantial current market for proteins used in a functional way. Protein ingredients in 16 major processed food categories represent a potential 9 billion pounds. Of this, about 3 billion pounds could be substituted. About 1 billion pounds of added proteins are already going into this market, leaving a 2-billion-pound potential. 3/

Two prospective changes may affect the proteins of our food industry during the seventies: a larger proportion of total proteins consumed by humans will be obtained from plant sources such as oilseeds, legumes, and grains; more proteins will be consumed as ingredients in fabricated foods.

Many unusual protein sources offer possibilities for the future. Proteins obtained from microorganisms grown on sewage and/or industrial waste or petroleum are technically possible. It is unlikely that protein from these sources will be developed and commercially available for human foods by 1980. However, these sources provide distinct possibilities for animal feed within the decade, freeing some proteins for human use.

In the decade ahead, the primary protein sources for human consumption will still be meats, fish, dairy products, eggs, legumes, and grains. The mix among these protein sources will be similar to that prevailing today.

3/ Hammonds, T. M. and Call, D. L., Utilization of Protein Ingredients in the U.S. Food Industry, A.E. 320, Cornell Univ., Ithaca, N.Y., 1970.

Animal and plant-derived proteins have some significant differences as well as many similarities. From a structural point of view, both sources are composed of amino acids, the building blocks of body protein. Animal-derived proteins generally are of a higher quality with the required proportions of the essential amino acids.

Because of essential amino acid imbalance, most plant proteins are less efficient, have lower digestibility, and a lesser biological value than animal proteins. A common measure of a protein's value is its protein efficiency ratio (PER) or its net protein utilization (NPU). For example, soy flour is higher in crude protein than meat, but has a lower protein efficiency ratio and net protein utilization. Another shortcoming is that the level of all amino acids may be too low to meet body needs.

The limiting amino acids in plant proteins are the key to their nutritional value. In soy, for example, methionine, one of the essential amino acids, is limiting. Corn, if not fortified by lysine, another amino acid, is an inadequate source of protein for humans. Use of additives to fortify plant proteins, development of improved strains of plants, selective use of plant proteins, and more sophisticated methods of extraction and handling can make them more adaptable for human diets.

One way of overcoming the amino acid deficiencies in plant proteins is to add synthetic supplements. Synthetic amino acids do not always yield satisfactory end products. At present, some are too expensive for widespread use as food supplements. Others have not been approved by the Food and Drug Administration because of their potential toxicity, and the testing procedure for approval requires considerable time and expense.

Combining plant proteins which have different limiting amino acids, such as soybeans and rice, produces a food with a better amino acid balance than either separately. Plant proteins are also upgraded by combining several foods with a supplement. Soybean flour may be upgraded by combining it with sesame flour, skim milk, or other animal products.

Genetic selection of corn and other grains can be used to upgrade the amino acid content. Opaque-2 corn, a new variety, is higher in amino acid content than ordinary corn. However, the price for the higher protein corn does not generate a return sufficient to offset the lower yield per acre.

Fats

Today's protein ingredient market is evolving similarly to the way vegetable oils substituted for edible animal fats. Price and functional characteristics of fats are the main factors

governing choice of ingredients by manufacturers. Because some specialized functional characteristics are difficult to develop from animal fats, substitute plant-derived fats and oils eroded a market vulnerable to substitution.

Vegetable oils have become common substitutes for animal fat in human foods. Margarine, currently made mostly from soy oils, has captured two-thirds of the table spread market. Vegetable oils form the principal fat ingredient in solid shortening and the only fat in salad and cooking oil. Recent estimates show nondairy coffee whiteners have about 35 percent of the light cream market, and substitute toppings have captured more than half the whipped topping market. Widespread substitution of vegetable oils for animal fats came about because of hydrogenation of solid shortening from vegetable oils, stabilized supply, and consumer concern over use of saturated fats. 4/

Sweeteners

Ordinary sugar, the major sweetener, is sucrose obtained from sugarcane or sugarbeets. The two most important characteristics of sugar are sweetness and nutritive content. Sugar substitutes of widely varying degrees of sweeteners have been developed. Some have nutritive value (caloric) while others are not nutritive (noncaloric).

Corn sirup and dextrose, caloric sweeteners derived from starch, are the most important nutritive supplements. Neither is as sweet as sugar, but they have important commercial attributes other than sweetness. For example, it is difficult and expensive to manufacture good hard candy without using at least 40-percent corn sirup.

Levulose is another caloric sweetener of potential importance as a competitor of sugar. Levulose is considerably sweeter than ordinary sugar. It can be obtained from certain plant sources by separating the levulose and dextrose and by chemical conversion of dextrose to levulose.

A small quantity of lactose, milk sugar, is produced in the United States and used for specialty purposes. It competes with sugar as an ingredient of certain mixtures containing lactose and some synthetic sweeteners.

Caloric sweeteners, some of which have been in use as long as sugar, include: Honey, maple sirup, and sorghum molasses. With the exception of honey, all have been slowly declining in

4/ Smith, Thomas B., Soybean and Cottonseed Oils Used in Shortening and Salad and Cooking Oils, MRR 898, U.S. Dept. Agr. August 1970.

importance. Per capita consumption of honey has remained relatively stable. These caloric sweeteners compete in some degree with sugar, although they are not often considered substitutes for sugar.

The principal noncaloric sweetener in commercial use is saccharin. Cyclamate, another noncaloric sweetener, was also used extensively until its use was restricted by the Food and Drug Administration in late 1969. Around 1960, mixtures of saccharin and cyclamate began to be used extensively in soft drinks. Lesser amounts were used in other food products and sold to consumers in retail outlets.

Other synthetic substances are known that are much sweeter than sugar. To date, none have been approved for use in food products. One such product, dulcin, is used to some extent in other countries.

Three new noncaloric sweeteners manufactured from flavonoids present in citrus waste have been discovered. They are intensely sweet, two of them about 150 times as sweet as sugar, and the third about 2,000 times. These sweeteners are not being marketed commercially, although they are being tested for use in food products.

Beverages

Loss of fluid milk and citrus juice markets concerns producers directly and all of agriculture indirectly, because many ingredients for the substitute products, particularly citrus substitutes, originate outside agriculture. Two classes of substitutes for fluid milk have been promoted--filled and synthetic milk. Filled milk contains vegetable fat (replacing animal fat) and nonfat milk solids. Coconut oil, a highly saturated fat, has been the main replacement for animal fat in milk. A polyunsaturated fat made from cottonseed and soybean oil has been used to a lesser extent in filled milk.

Synthetic milk does not contain any milk components, except sodium caseinate, a chemical product derived from milk. Major ingredients in synthetic milk products are vegetable fat, protein, emulsifiers, buffers, stabilizers, body agents, and sweeteners. The nutritional value of synthetic milk at present is low compared with milk, and the flavor is generally not comparable. Decisions regarding regulations, the pricing policy for milk components, standards of identity, and labeling will be important in determining the future of both filled and imitation milk products.

Filled milk has been sold in at least 18 Federal order markets. Two markets, Arizona and Oklahoma, accounted for a large proportion of filled milk sold. However, total sales of

filled milk amount to only a fraction of 1 percent of U.S. sales of fluid whole milk. In the Central Arizona market, filled milk reached a peak of more than 10 percent of fluid milk sales in late 1968, but sales have since declined to less than 1 percent in July 1971. 5/

Other high-protein drinks are being developed and marketed. These drinks do not have the flavor and color of milk and are not intended as direct substitutes. If marketed successfully, however, part of their growth probably would be at the expense of fluid milk sales.

Most fruit juices substitute for each other to some degree. Canned and frozen products substitute for fresh juices. In the past few years, citrus juices have faced stiff competition from an array of substitutes and synthetics. Substitutes are citrus-flavored drinks containing both natural and synthetic ingredients. They are available in single-strength form in cans, bottles, and cartons. Concentrated substitutes are available in frozen form. Synthetic drinks do not contain any natural citrus solids and are available as powder or frozen concentrate. Synthetics and substitutes account for about 21 percent of the 600-million-gallon retail citrus beverage market. Synthetics have about 12.5 percent of the market. Trends in consumption of natural and synthetic drinks are given in appendix 1.

Introduction and establishment of citrus juice substitutes and synthetics have been closely correlated with shifts in the supply and quality of natural citrus juices. Shortages of supply due to winter freezes increased the prices of citrus juices, resulting in increased sales of other natural fruit juices. However, other noncitrus juices were often not able to fill completely the void created by a short supply of orange juice. This shortage served as an incentive for orange substitutes and synthetics to enter the citrus juice market. 6/ Following the Florida freeze in the late 1950's, a synthetic orange powder was introduced. In the early 1960's, a synthetic frozen concentrated orange drink was marketed along with numerous substitute citrus drinks. Manufacturers have timed the introduction of synthetic and substitute drinks and maintained a quality product at stable prices. Citrus products have experienced difficulty in recapturing markets after periods of short supply.

5/ Call, David L.; Fluid Milk Substitutes - Current Status and Expected Trends, Cornell Agricultural Economics Staff Papers, No. 7, Feb. 1970.

6/ Polopolus, Leo and W. E. Black, Synthetics and Substitutes and the Florida Citrus Industry, Report No. FCC-ERD 66-4, Economic Research Department, Florida Citrus Commission, Lakeland, Fla., April 1966.

Market shares for citrus beverages changed when substitutes and synthetics were introduced (appendix 2). From 1960 to 1962, data on the consumption of orange drink and synthetic orange drinks were not available, and frozen concentrated orange juice held approximately 76 percent of the citrus beverage market. But, by 1969, it had decreased to 53.4 percent. Because the market for all types of juices has increased, it is not possible to determine from these data the inroads of substitutes and synthetics. Part of the change in market shares could be due to creating new markets. For example, powdered orange synthetic has created new markets, such as campers and college students, as well as competed with natural citrus juices.

With the exception of powdered orange synthetic, retail prices for citrus and substitute products varied considerably during the past decade (appendix 3). However, with few exceptions, substitutes show less yearly price fluctuations than natural citrus products.

Apparel and Furnishings

Cotton

Cotton has been subjected to severe competition from synthetics for the past several decades. First, rayon made severe inroads into many uses that were formerly exclusively cotton. Price was a major reason for the successful incursion. In the early 1960's, a high wet modulus rayon was introduced at about 32 cents per pound. Prices for cotton rose during the early 1960's to about 36 cents per pound landed at the mill, creating a favorable situation for the market entry of the new synthetic.

Until recently, prices for the new rayon and regular rayon were in the 35 and 25 cents per pound range, respectively. However, these products increased in price in early 1971. The price increase for high wet modulus rayon followed an upward trend in the price for cotton caused by a worldwide cotton shortage. Present price margins between rayon and cotton fibers are very narrow.

With the introduction of polyester, fiber manufacturers and the textile industry capitalized on polyester's easy care and longer life as selling points. Initially, price was not a major consideration. Branded polyester was first priced well above cotton, with restrictions on the cotton content in fabrics using polyester. As more firms manufactured polyester, branded prices decreased substantially. Recently, unbranded prices have been as low as 28 cents per pound, compared with a branded price of 37 cents.

The quantity of synthetics produced reflects many factors, including cotton prices. High cotton prices usually generate a significant increase in the manufacture of fabrics containing blends of cotton and polyester. Even at equal prices per pound, clean fiber costs favor synthetics. Synthetic's waste factor is about 2-3 percent, compared with cotton's 8-23 percent (net weight basis), depending on whether it is a carded or combed cotton.

Exports of raw cotton and imports of finished textiles goods influence the price and production of domestic fabrics. In the 1950's, foreign countries could purchase U.S. raw cotton at a lower price per pound than could U.S. manufacturers. The lower cost of cotton, combined with a lower wage scale in many foreign countries, increased their incentive to produce textiles for export to the United States.

In the early 1960's, an agreement was reached to limit imports of cotton manufactured products into this country. Since 1964, annual imports of cotton textiles have been fairly stable. However, imported fabrics made of blends of cotton and synthetics, pure synthetic fabrics, and synthetic fibers or yarns increased significantly between 1964 and 1970. Imports of cotton and manmade textile products accounted for about 22 percent of total broadwoven fabrics available in 1970--up from 8 percent in 1964. Production of manmade fiber fabrics equaled the decline in broadwoven cotton fabrics over the same time period. The increase in supplies of broadwoven fabrics between 1964 and 1970 was for the most part supplied by imports (table 1).

Production of fine all-cotton broadwoven fabrics decreased in the past decade, dropping from 1.5 billion linear yards in 1960 to slightly less than 0.5 billion yards by 1970 (appendix 4). In contrast, fabrics manufactured with a blend of cotton and polyester increased more than fourfold from 1964 to 1970 (appendix 5). Fine fabrics are manufactured primarily for the apparel market where the price of raw material generally is a secondary factor.

Price is usually the prime factor in sales of coarse or medium yarn cotton fabrics. Therefore, cost of the basic fiber used in manufacturing these fabrics is of primary consideration. Coarse or medium yarn fabric production has decreased by almost one-fourth over past decade (appendix 6), compared with a decrease of two-thirds in the production of fine cotton fabrics for the same period.

Wool

Shorn wool production in 1970--all for apparel use--was valued at more than $57 million plus Wool Act payments of $51 million on shorn wool, making a total of $108 million to producers. Imports of raw apparel wool have varied. However, in the past decade they have averaged about as large as U.S. production.

Table 1.--U.S. production of broadwoven fabrics and imports of textile products, by category, 1964-70 1/

Year	U.S. production		Imports		Total available	Total imported
	Cotton	Manmades 2/	Cotton	Manmades 2/		
	---Billions of square yards---					Percent
1964	11.1	4.9	1.1	0.3	17.4	8
1965	11.6	5.4	1.3	0.6	18.9	10
1966	11.2	5.9	1.8	0.8	19.7	13
1967	10.6	6.0	1.5	0.9	19.0	13
1968	9.7	7.3	1.6	1.5	20.1	15
1969	9.2	7.6	1.6	1.8	20.2	17
1970	8.3	7.1	1.6	2.7	19.7	22

1/ Source U. S. Department of Commerce.
2/ Includes blends and all-synthetics.

The price of wool dropped to 35.5 cents per pound in 1970, the lowest in 10 years. Direct payments to producers of wool have raised the price to specified support levels. 7/

U.S. consumption of wool trended down during the 1960's. Wool's share of the total fiber market dropped from 8.2 to 3.5 percent over the decade. The fiber mix used in woolen mills has changed substantially in the last 5 years (fig. 1). Since 1967, manmade fibers have surpassed raw wool as the major fiber processed in woolen mills.

Wool used in apparel declined from a high of 2.1 pounds per capita in 1962 to 1.3 pounds in 1970. Per capita use of apparel wool showed considerable variation during this period. Since 1964, wool's share of the men's and boy's apparel market has remained at about the same level, although experiencing year-to-year fluctuations (fig. 2). In this category, the major loss has been in tailored civilian uniforms. There was a slight decrease in wool's share of fiber going into medium and light suits but a slight gain in market shares in outdoor jackets and athletic clothing. In other categories, wool's share of the fiber market remained about the same.

7/ Much of these data taken from an article by Larry B. Clayton, "Wool in the United States: Major Trends and Prospects," Wool Situation, August 1970.

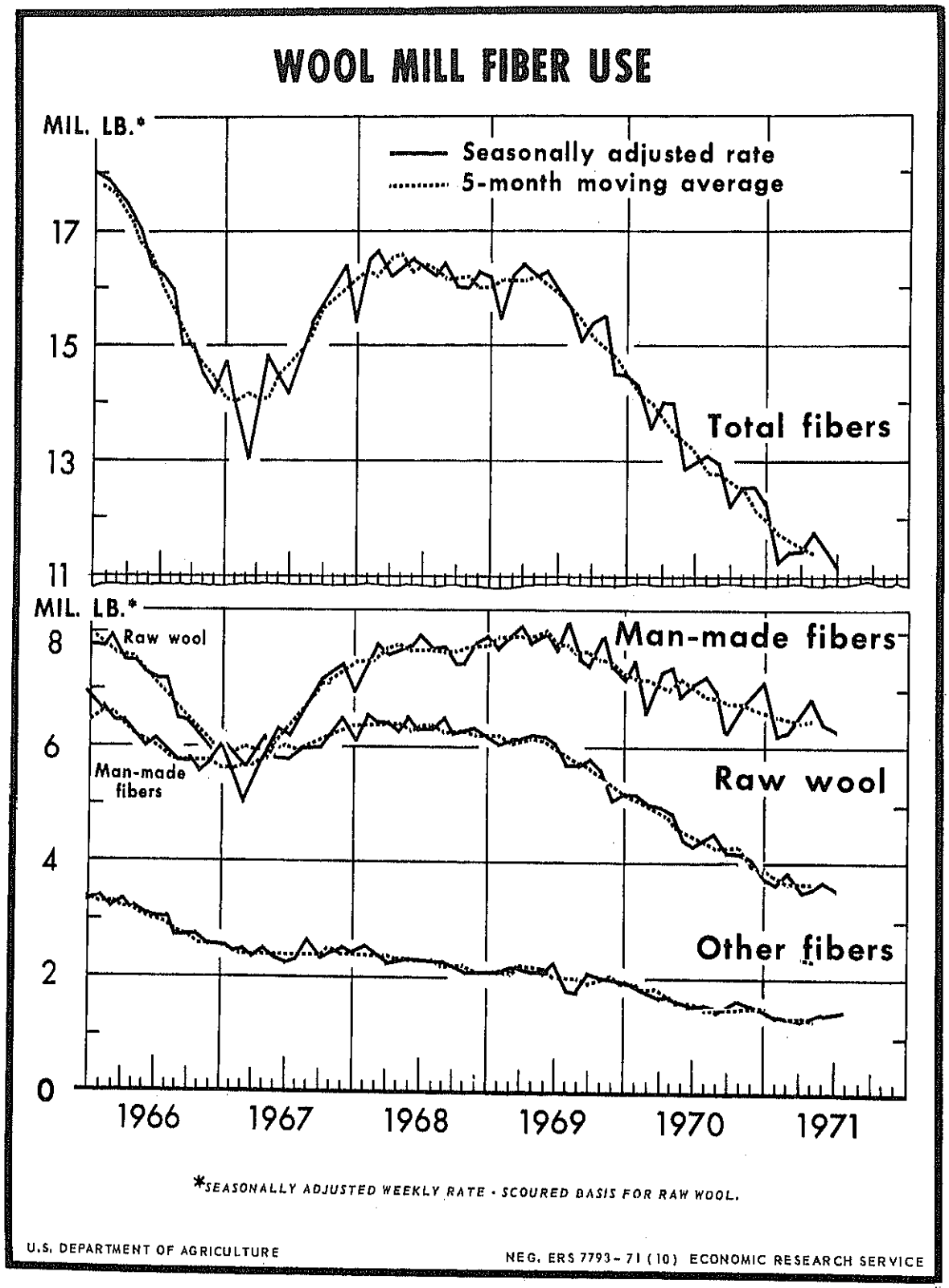
WOOL MILL FIBER USE
MIL. LB.*
Seasonally adjusted rate
5-month moving average
17
15
13
11
Total fibers
MIL. LB.*
8
6
4
2
0
Raw wool
Man-made fibers
Man-made fibers
Raw wool
Other fibers
1966
1967
1968
1969
1970
1971
*SEASONALLY ADJUSTED WEEKLY RATE - SCOURED BASIS FOR RAW WOOL.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 7793-71 (10) ECONOMIC RESEARCH SERVICE

Figure 1

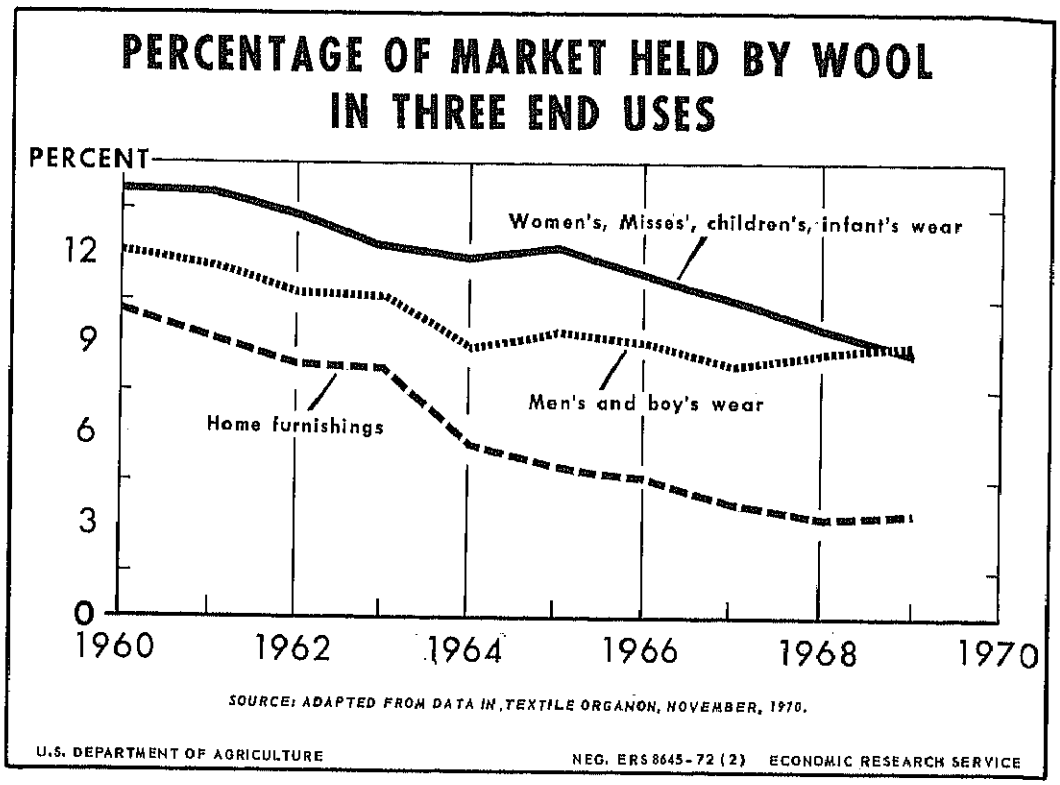

Figure 2

Synthetic fibers have made greater inroads in wool's share of the women's and children's apparel market than in men's and boy's wear (fig. 2). There has been a decline over the past 10 years in wool's share of the market in almost all types of women's and children's wear except for sweaters where the market share remained about the same.

Wool for apparel use goes primarily into high-priced garments. Purchases of more expensive garments are highly vulnerable to changes in the economy reflecting shifts in consumer buying power. This is probably the largest factor explaining short-term fluctuations in consumption of apparel wool. Reductions in military orders explain part of the recent decline in wool for apparel use. Also, the downtrend in apparel wool since 1965 reflects market inroads by synthetic fibers. Knitted synthetic fabrics, with sharply increased popularity in the last couple of years could cause further inroads in wool used for apparel. But experience indicates that fabrics manufactured for leisure wear from synthetic fibers are lacking in ability to "breath" or transfer heat, thus making them less comfortable than garments made from natural fibers. This shortcoming may moderate the losses that have been underway in wool's share of total fiber use.

In 1969, wool for carpeting accounted for about 92 percent of the wool used in home furnishings (fig. 2). Wool's share of fiber used in carpets and rugs dropped drastically from 1964

to 1969; however, the rate of decline is slowing (table 2). The quantity of wool used in carpets increased by about 10 million pounds between 1967 and 1969. The rapid growth in the carpet market has stabilized wool used in carpets at about one-half pound per capita.

Leather

Leather's many uses include shoe soles, shoe uppers, bags, upholstry, and garments. Hides, the source for leather, are a byproduct of the slaughter of cattle and other domestic animals. The number of cattle slaughtered has increased over the past decade, making available a larger supply of hides for leather.

The use of cattle hides in manufactured products has steadily declined (table 3). Declining demand for leather may be attributed to substitution of other materials and a general overall decline in market demand for leather products. Leather formerly used in industrial belting, luggage, and, upholstry has been replaced in part by synthetic materials such as plastic and rubber. In many instances where substitution occurred, price was of secondary importance compared with the functional advantage of the substitute material. Recent fashion changes have led to increased use of leather in garment manufacturing. Exports of cattle hides have increased sharply, currently constituting an important market outlet.

Table 2.--Fibers used in carpets and rugs, 1964-69

Year	Manmade		Cotton		Wool		Total fiber
	Million lbs.	Pct.	Million lbs.	Pct.	Million lbs.	Pct.	Million lbs.
1964...	458.0	67.2	101.1	14.8	122.7	18.0	681.8
1965...	572.0	72.6	104.0	13.2	112.3	14.2	788.3
1966...	647.1	76.9	91.2	10.8	103.6	12.3	841.9
1967...	738.4	81.0	89.2	9.8	83.9	9.2	911.5
1968...	970.7	85.5	73.2	6.5	91.3	8.0	1,135.2
1969...	1,086.4	87.4	62.6	5.0	94.1	7.6	1,243.1

Source: Compiled from data in Textile Organon, November 1970.

Table 3.--Estimated domestic cattle hides available, exports and leather produced, 1954-70 1/

Years	Estimated total cattle hides available	Net exports	Sole leather	Shoe side upper leather including cattle patent and lining leather	Total hides used for shoes	Bag, case, and strap leather	Upholstery leather	Glove and garment	Belting and mechanical leather	Misc. cattlehide leathers 2/	Total of net hides exported and leather produced 3/
	1,000 hides										
1954-56	28,326	4,958	5,544	16,366	21,910	858	700	888	609	362	30,285
1957-59	26,539	4,817	4,906	16,435	21,341	882	397	745	429	371	28,982
1960-62	28,039	6,876	4,225	15,890	20,115	862	380	355	405	292	29,285
1963	29,800	7,612	3,909	15,575	19,484	733	450	353	346	288	29,266
1964	33,262	11,226	4,193	16,340	20,533	736	486	411	364	304	34,060
1965	34,550	13,019	4,321	16,641	20,962	780	526	480	319	369	36,455
1966	35,260	13,984	4,455	16,969	21,424	685	522	505	293	401	37,814
1967	35,381	11,634	4,301	16,777	21,078	639	510	560	245	362	35,028
1968	36,506	12,359	4,116	17,356	21,472	615	634	671	266	375	36,392
1969	36,675	14,513	3,377	15,986	19,363	555	711	761	251	389	36,543
1970	36,500	14,844	2,675	15,219	17,894	480	560	798	239	382	35,197
	Percent										
1954-56		16.4	18.3	54.0	72.3	2.8	2.3	2.9	2.0	1.2	100
1957-59		16.6	16.9	56.7	73.6	3.0	1.4	2.6	1.5	1.3	100
1960-62		23.7	14.4	54.3	68.7	2.9	1.3	1.2	1.4	1.0	100
1963		26.0	13.4	53.2	66.6	2.5	1.5	1.2	1.2	1.0	100
1964		33.0	12.3	48.0	60.3	2.2	1.4	1.2	1.1	.9	100
1965		35.7	11.9	45.6	57.5	2.1	1.4	1.3	.9	1.0	100
1966		37.0	11.8	44.9	56.7	1.8	1.4	1.3	1.0	1.1	100
1967		33.2	12.3	47.9	60.2	1.8	1.5	1.6	.7	1.0	100
1968		34.0	11.3	47.7	59.0	1.7	1.7	1.8	.7	1.0	100
1969		39.7	9.2	43.7	53.0	1.5	1.9	2.1	.7	1.1	100
1970		42.2	7.6	43.2	50.8	1.4	1.6	2.3	.7	1.1	100

1/ Source: Leather Industry Statistics 1971 Edition, Trade Survey Bureau, Tanners' Council of America, Inc.
2/ Miscellaneous cattlehide leathers include harness, skirting, collar, latigo, lace, and other.
3/ For some years total of net hides exported and leather produced is greater than the number of hides available. This results from not taking changes in inventories into account.

The percentage of cattle hides used in shoes has declined. Longer wearing synthetic materials are replacing leather in shoe soles. Increased use of injection molding and direct vulcanization to form and attach soles made of synthetic materials to uppers contributed to the decreased use of leather shoe soles. In 1969, only about 15 percent of nonrubber boots and shoes had leather soles. About 69 percent of nonrubber boots and shoes had leather uppers. However, the percentage of shoes with leather uppers declined from 1965 to 1968, then increased slightly in 1969 (fig. 3). Poromeric uppers were introduced in 1964. Use of this new synthetic material plus vinyls and sheet plastic led to the decline in use of leather uppers beginning in 1964.

Poromeric materials simulate natural leather by allowing passage of moist air out and resisting the passage of water from outside. Synthetic poromerics are more scuff resistant than leather and do not require waxing. Present poromerics have certain disadvantages relative to leather. Shoes made from these synthetic materials do not stretch as do shoes made of leather, involving the problem of a proper fit. Shoes made of poromerics may have noticeable folds around the lower edge of the toe formed during manufacture and do not allow moisture to be absorbed from the foot as do leather shoes. Shoes made with vinyl also have disadvantages because they do not breathe and may crack or peel over time.

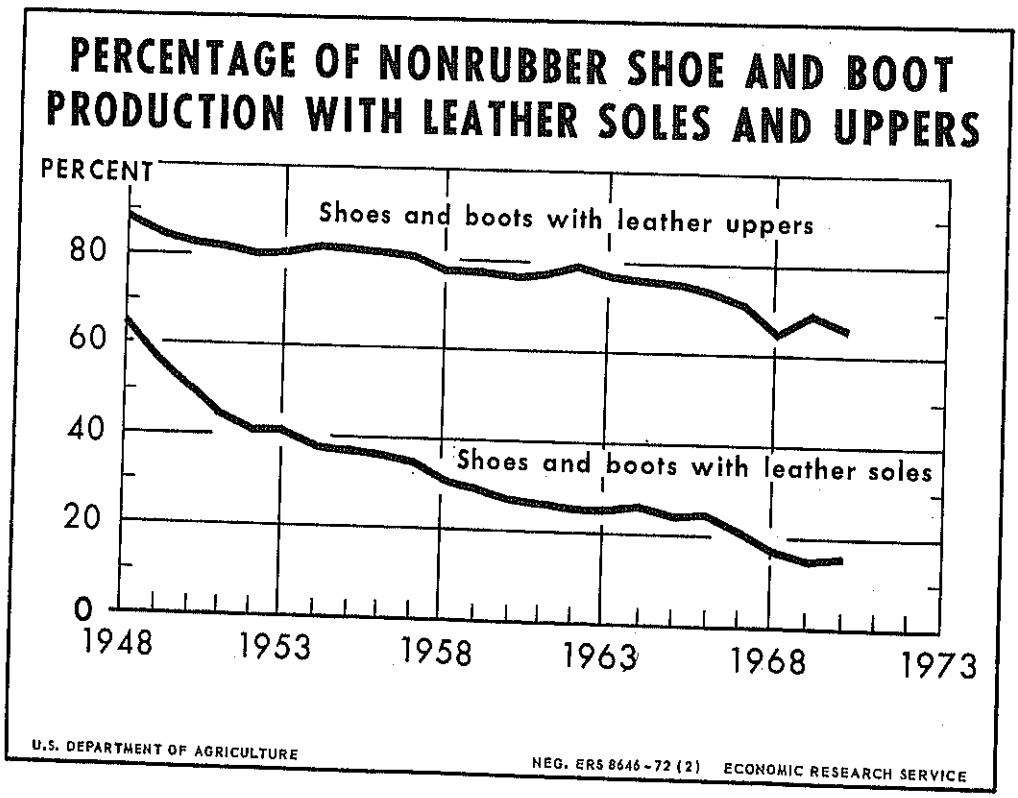

Figure 3

In manufacturing, synthetic upper materials have the vantages of uniform color, thickness, and surface texture. re cutting automation may be used with synthetics compared th leather, thus reducing waste. Other steps in shoemaking e about equal for synthetics and leather. Sheet vinyls are e least costly nonleather materials, followed by fabric backed ıyl; both are less costly than leather. However, poromeric terials are competitively priced with leather.

Industrial

Agriculture provides raw materials for adhesives, paints, ›er, detergents, textiles, gypsum board, and many other iustrial products. These industrial materials come primarily ›m grains, oilseeds, inedible tallow and grease, and tall oil. ›ducers of synthetics have successfully penetrated many of ese industrial markets.

The largest and fastest growing market for cereal starches the paper and paper board industry which accounts for more ın one-half of all industrial uses of cereal starches. Starch ed in paper products has increased 5-6 percent per year recent-, offsetting loss of starch in other industrial uses. The ctile industry is the second largest industrial user of starch ch about one-sixth of all industrial usage. Synthetic resins ve reduced the amount of cereal starch used in textile finish-g. The adhesive market was long dominated by starch, but ıthetics have been especially strong in displacing starch in ls outlet. A major reason was the versatility of synthetics ed in new formulations required to meet the growing applications adhesives. The annual growth rate for synthetic resins used adhesives was 13.8 percent for 1950-65, compared with a recent ıual growth rate for all adhesives of about 7 percent per year. e of cereal products in producing ethyl alcohol is declining, tle production from synthetic raw materials is increasing.

Fats and oils have many industrial applications--in the emical industry, soaps, and drying agents. Whether the fat iginates from vegetable or animal sources is of little concern the industrial user. Generally speaking, fats and oils from getable, animal, and marine sources compete with each other. recent years, oil and fat from these sources have been replaced plastics and synthetic resins.

Use of linseed and soybean oil, the major vegetable oils ed in drying applications, has steadily decreased in the last › decades as synthetics have continued to penetrate this market. ring oil is used primarily in paint manufacture. However, the end toward more water-emulsion latex paint decreases the market drying oil in paint. Other uses for drying oils include nting ink, caulking compounds, floor covering, and oil cloth.

Vegetable oils are being replaced in varying degrees in all these applications. There are few new uses for drying oil and present uses are only holding steady or declining. Thus, the downward trend in the use of drying oil is likely to continue.

Soap manufacturing has been one of the largest industrial markets for fats and oils. Synthetic detergents, primarily of petroleum origin, now account for a major share of this market. With present technology and prices, detergents can be produced at a lower cost from petroleum products than from fats and oils. The growth rates for detergents have slowed in recent years and will continue to decline unless detergents are more successful in penetrating the toilet bar soap market. Also, pollution problems associated with detergents could reverse the trend and increase the use of biodegradable materials such as natural fats.

Fat derivatives are used in paints, printing inks, metallic driers, soaps, detergents, flotation agents, and other industrial uses. Inedible tallow and grease and tall oil are the major raw materials for producing fatty acids. Petroleum is a potential threat in production of synthetic fatty acids, but so far the prices of tallow and tall oil have been low enough to prevent significant market penetration by petroleum-derived fatty acids.

Specific projections of industrial uses for agricultural products in 1980 are not included in this study. Industrial uses of agricultural products and the trends in use of synthetics were studied in some detail in a previous work 8/.

PROJECTED SUBSTITUTION FOR ANIMAL PRODUCTS

Substitutes for Meats

Until recently, many considered the meat market immune to invasion by substitutes because of strong consumer loyalty and taste preferences. The attitude prevailed that food processors could not possibly duplicate meat's texture, flavor, and nutritional qualities. Most attempts in the past bore this out--substitutes were decidedly inferior on both palatability and nutritional scores. Now, the technology of fabricating foods from vegetable proteins has been so improved that substitutes for meats command attention.

Other developments also led to the current interest in meat substitutes. Adverse publicity over the use of animal fat in the diet has been important. Public desire to remedy nutritional

8/ Synthetics and Substitutes for Agricultural Products - A Compendium, ERS, U.S. Dept. Agr., Misc. Pub. No. 1141, April 1969.

deficiencies of the needy has had a role. The lower cost of vegetable protein has provided an incentive to use them to upgrade diets of low-income people both here and abroad. As an outgrowth of these pressures, food technologists have developed a number of protein foods designed to replace meat.

Vegetable protein is prepared for two general purposes--as a partial or complete substitute for meat in processed items--patties, chili, casserole-type dishes, etc.--or as meat analogs that resemble specific meats in texture, color, and flavor.

Four major types of defatted soy protein products are being used for human food. They are flour and grits, concentrates, isolates, and textured items. All come from clean, dehulled soybeans, but differ in protein content, physical and chemical properties, food application, and price.

Flour and grits are simplest in form and lowest in protein. Concentrates ranging between 60 and 70 percent crude protein, and isolates between 90 and 97 percent crude protein are higher in price than flour and grits. Higher prices of concentrates and isolates result from additional processing costs and lower yields of the finished products. Textured products are made from any of the above items and have prices in excess of any one component.

In 1970, a survey revealed 17 firms producing soy protein for human consumption in one form or another. Of the 17 firms, 11 produced flour and grits, 4--concentrates, 3--isolates, and 8--textured products (table 4). In some cases, a firm produced more than one product. Several new companies have come into production recently and other firms contemplate entry into the market.

Meat analogs have been marketed for some time. These products have been manufactured primarily for people who prefer not to eat meat for personal, religious, or health reasons. Recently, more firms have entered this field and have begun to expand the market through promotion. Bacon-type analog bits used for flavoring such dishes as salads are being distributed nationally. Meat analogs in other flavors are being sold for institutional use.

The recent entrants into meat analog production are large firms that have the capability to analyze market potential and develop large-scale production methods. Some of their production equipment is patented, thereby limiting competitors who would have to buy or develop other types of production equipment.

Certain meat analogs have become price competitive with meat in cost per portion served after cooking. This cost factor helps explain why analogs have entered the institutional food service market. Since consumers usually compare food prices on a precooked

Table 4.--Estimated U.S. production of soy protein foods, 1970

Soy protein food	Protein content	Price	Estimated 1970 production	Current uses
	Percent	Cents per lb.	Million lb.	
Flour and grits 1/	40 - 55	5½-11½	500 - 600	Ingredients for baked goods, dog foods, sausages
Concentrates	60 - 70	18 - 25	35	Manufacturing textured products; ingredient in processed meats, baby foods, health foods
Isolates	90 - 97	35 - 45	25	Manufacturing analogs, for use in comminuted meats, such as meat loaf, frankfurters, etc.
Textured items 2/				
Extruded	50 - 55	28 and up	30	Bacon strips and bits; pork, beef, chicken, fish, ham, and similar foods
Spun	90+	50 and up		

1/ Flour and grits, although handled differently and sold for different uses, are essentially the same product. Both are ground defatted flakes. Grits are coarse (larger than 100 mesh); flour is fine ground (smaller than 100 mesh).

2/ Textured items are of two distinctly different types. Extruded items, made from flour are textured by high-temperature, high-pressure extrusion, using a plastic type extruder. Spun items, made from isolates, are spun, using somewhat the same technique used in rayon or nylon.

basis, analogs appear more expensive than meat. However, if prices were compared on a cost per unit of utilizable protein basis, the meat analogs would compare much more favorably.

Labeling regulations, standards of identity, and tastes are also factors that may limit meat analog expansion in the next 5-10 years. The Food and Drug Administration is currently working on regulations for both extenders and meat analogs. Present indications are that analogs will be required to duplicate meat in every nutritional respect since they are to substitute for meat. A ruling requiring exact nutritional duplication would further slow the development and introduction of new analogs. Work is continuing on improvements in flavor and texture. Changes in technology, market acceptance, and regulations take time. It is expected that by 1980 analogs will comprise only a small proportion of the red meat market, because the advantage of lower prices of analog ingredients will not be fully realized owing to other constraints and limitations.

Soy protein extenders for meat products include analogs, extruded soy protein, soy concentrate, and flour or grits. The first major penetration for the extender-type soy proteins will be the institutional market, including hospitals, schools, and other institutions that must provide nutritious meals under food budget restraints. Certain types of restaurants are also prime initial markets for vegetable protein products. Food served in restaurants is not subject to the same labeling and identification requirements as food sold for home consumption. However, use of soy product extenders in restaurants will probably be restricted initially to items such as meat loaf and patties. The trend toward more away-from-home eating increases the potential of this market for extenders. By 1980, vegetable protein extenders will probably displace a significant quantity of the meat in meat-type foods in institutional markets. The retail market will develop slower than the institutional one.

Red Meats

For red meats, the major market penetration will be in processed items where the soy protein extenders replace part of the meat. The major incentive for their use will be reduction in cost of processed items.

To illustrate the impact on costs from the use of soy protein extenders, sample patty mixes were formulated using 30-percent fat and soy extenders plus an all-meat patty with 30-percent fat (table 5). The 30-percent soy extender includes the water needed to rehydrate the particular extender. The cost of the soy mix was much less than the all beef patty, ranging from about 38 to 41 cents per pound. The all beef patty mix cost about 62 cents per pound. Soy concentrate was used to estimate the impact of

Table 5.--Cost of beef-type patty mixes

	Price per pound	All natural meat		Patty with soy concentrate		Patty with extruded soy		Patty with spun soy	
		Percentage used	Cost	Percentage used	Cost	Percentage used	Cost	Percentage used	Cost
	Cents	Pct.	Cents	Pct.	Cents	Pct.	Cents	Pct.	Cents
Boneless chuck	66.75	93.33	62.30	53.33	35.60	53.33	35.60	53.33	35.60
Fat trim 1/	2.00	6.67	.13	16.67	.33	16.67	.33	16.67	.33
Soy concentrate	25.00			7.50	1.88				
Extruded soy	32.00					10.00	3.20		
Spun soy (dry)	63.00							7.50	4.73
Water	0.00			22.50		20.00		22.50	
Total		100.00	62.43	100.00	37.81	100.00	39.13	100.00	40.66

1/ Fat added to approximate the 30 percent allowed under current U.S. Department of Agriculture regulations.

extenders in processed meats since it provides the greatest cost savings. However, other soy extenders have functional properties offsetting their higher cost and would be used in many products, particularly at higher levels of use. Regardless of the soy extender used, the meat replaced and soybeans needed would not change significantly.

The first step in projecting market penetration of processed meats by substitutes was to estimate total quantities of processed meats now produced and make projections to 1980. Secondary data for pounds of processed meat, prepared food products, and canned items under Federal inspection were used to estimate 1980 production of processed meats (appendix 7).

Data were adjusted to reflect non-Federally inspected processing and production of hamburger, including beef ground by retail outlets. Fresh finished sausage, hamburger, and miscellaneous meats were calculated at the same output as that for Federally inspected plants. Also, non-Federally inspected plants were assumed to produce one-fourth as much sausage to be dried, franks, weiners, bologna, etc., as Federally inspected plants. The total pounds of hamburger were further increased by 18.4 percent of the steer and heifer slaughter to account for beef ground at the retail level.

Pounds of processed meat were converted into percentages of total slaughter for 1968 and 1969 and applied to total slaughter estimates for 1980. Then the two estimates were averaged to yield a final projection for pounds of processed meat in 1980.

Three estimates of the substitution of soy protein were made for meat used in processed items (appendix 8). On rehydrating, the protein content of the soy protein would be approximately that of the meat in the item. Current regulations allow the addition of soy protein concentrate up to 3.5 percent in sausage products, if properly labeled. This percentage was taken as the low level of soy protein use. The high level of soy protein use assumed approximately 63 percent of the protein from animal sources and 37 percent from vegetable. The medium estimate of soy protein use was between the high and low estimate. The high level of penetration is assumed to be the upper limit based on information currently available. Other estimates indicate as much as 50 percent of the animal protein in processed meats might be replaced by vegetable 9/.

Assuming that soy protein replaces meats in the processed products formulation, the total pounds of processed meat products would remain the same as the 1980 projections. The amount of

9/ Saffle, Robert. See Yourself as Processor of Food to Prosper in 70's, The National Provisioner, Volume 163, No. 1. July 4, 1970.

hydrated soy concentrate and spun soy protein are projected for three levels of potential substitution: low, medium, and high (table 6). Meat replaced varies from 10 to 21 percent of total processed meats.

The number of meat animals needed to supply meat for these products will be reduced by each level of market penetration for soy protein. Because ingredient formulas for processed meat items and pounds of meat available from each class of animal were not known, certain assumptions were made. The ratio of beef to total red meats produced on a carcass-weight basis was used to determine the ratio of beef in processed meat items. Projections indicate that beef will represent 65 percent of the total red meat production in 1980. Thus, it was assumed that 65 percent of the meat replaced by soy proteins was beef. Percentages for pork, lamb, and mutton were developed in a similar manner. Carcass weights of these animals were assumed to be the same as the 1968-69 average. The kind and number of animals that would be replaced under the three levels of market penetration by soy proteins were calculated. The number of animals displaced ranged from 4 to 8 percent of estimated 1980 production (table 7).

Poultry Meat

The per capita consumption of chicken meat nearly doubled from 21 pounds in 1955 to 41 pounds in 1970. Per capita consumption of chicken and turkey may approach 60 pounds by 1980. This projected level could be reduced, however, as poultry meat faces increased competition from substitutes in the years ahead.

To date, the development of substitutes competing directly with poultry meats is on a small scale. Market information and historical data are lacking for precise statistical projections.

Market penetration probably will be in the form of substitutes for poultry used in further-processed items. Because of flavor and texture problems, it is technically easier to produce chicken products containing vegetable protein than an analog. Besides, poultry meat is relatively expensive in further-processing because of the loss and cost of deboning.

Because of the need for precise portion control and less on-premise preparation, the largest market for many processed poultry items is institutional outlets. Exceptions include consumer acceptance of TV dinners and pot pies made from poultry meat. However, the institutional market is more susceptible to penetration by substitutes. In the short run, consumer acceptance would probably be greater if the substitutes were in items that retained the identity of chicken rather than if introduced in completely new dishes.

Table 6.--Projected processed, prepared, and canned meat items and pounds, of meat replaced, using three levels of hydrated soy concentrate or spun protein, 1980

Meat items	Total pounds of processed meat items	Soy protein substituted for meat		
		Low level	Medium level	High level
	Million lbs.			
Processed or prepared				
Cooked beef	113	0	0	0
Cooked pork	184	0	0	0
Other cooked meats	36	0	0	0
Fresh finished sausage	623	104	162	208
Sausage to be dried	257	28	56	79
Franks, weiners	1,399	233	363	466
Bologna	712	138	188	237
Other smoked or cooked sausage	783	152	207	261
Loaf, head cheese, chili, jellied products	359	7	14	20
Hamburger, including ground beef	5,194	866	1,484	1,948
Bacon	1,878	9	13	19
Other sliced meats	924	99	179	245
Miscellaneous meat product	535	74	117	153
Frozen foods-dinners, meat pies, etc.	942	7	12	17
Canned meats				
Plain meats	1,019			
Italian dishes	433	12	17	22
Mexican dishes	352	14	19	23
Stews and hash	355	18	28	35
Soup	894	1/	1	1
All other with meat/or meat by-products				
20% or more meat	274	14	21	27
Less than 20% meat	514	11	17	22
Total	17,780	1,786	2,898	3,783
Percentage of meat replaced in total pounds of processed meat items		10%	16%	21%

1/ Less than 500,000 pounds.

Table 7.--Projected impact of soy substitution on pounds of meat, kind, and number of livestock replaced, 1980

	Meat replaced	Head replaced	Percentage of estimated 1980 production
Impact of low level	Million lbs.	Thousands	Pct.
Cattle and calves	1,166	1,943	4.0
Hogs	602	3,984	4.0
Sheep and lambs	18	357	4.0
Impact of medium level			
Cattle and calves	1,892	3,154	6.5
Hogs	977	6,468	6.5
Sheep and lambs	29	580	6.5
Impact of high level			
Cattle and calves	2,471	4,118	8.5
Hogs	1,275	8,444	8.4
Sheep and lambs	38	757	8.5

The quantity of chicken and turkey used in further-processed items was estimated for 1980 (appendix 9). Data were for chicken and turkeys slaughtered in plants under Federal inspection. Total quantities of chicken and turkeys estimated for use in further-processing were broken down into quantities going into such items as rolls, pot pies, canned poultry, etc. (appendix 10).

Low, medium, and high projections of market penetration by substitutes were made for each further-processed item. Individual estimates were summed to obtain the total market penetration by substitutes for chickens and turkeys (appendix 11).

The low projection assumed that labeling regulations and packaging will remain essentially unchanged in 1980. Furthermore, it was assumed that substitute products will not capitalize on the market strength of traditional poultry products; technological changes, deboning, and processing will enable chicken meat to remain competitive with substitutes; and new poultry products will be developed to compete with the convenience of substitutes. Medium and high projections of market penetration indicate a change in one or more of the assumptions.

Different estimates were made to allow for basic differences between the poultry meats. Young chickens are grown primarily for marketing as fresh chicken. They are somewhat higher in cost as an ingredient for further processed items and more tender than mature chickens. A very small percentage of young chickens are used in further-processed items. Two major analogs are currently produced that compete with young chickens, one resembling chicken breasts and the other drum sticks. Substitutes will probably not replace meat from young chickens to the same extent as meat from mature chickens and turkeys.

The percentage of mature chickens going into further-processed items reached 84 percent in 1968. More than 90 percent is projected for use in further-processing by 1980. Substitutes for meat from mature chickens include canned chunks and slices of vegetable protein with a chicken flavor, chicken style pot pies, and a number of textured protein products used to supplement further-processed products made with chicken.

By 1980, 45 percent of the turkeys slaughtered will go into further-processed items. Substitute products on the market compete with turkey roasts and sliced turkey. Other turkey products are under development.

At present prices, soy protein ingredients are lower priced than chicken. Soy concentrates sell for 18-25 cents per pound. At protein levels comparable to chicken, the cost would be 6-8 cents per pound for ingredient cost. Soy concentrates are used in many manufactured products not requiring the texture of meat and where a deviation in flavor would not be noticed. Isolates cost 35-45 cents per pound and are used to produce chicken analogs. The ingredient cost would be about 9 cents per pound for isolates in this use. Cost of fabricating chicken analogs is quite high at present. For example, the cost of 100 grams of protein from chicken breasts was $0.99 compared with $1.88 for 100 grams of protein in an analog of white chicken meat. The 1969 average retail price of chicken breasts in metropolitan areas was $0.74 per pound.

Estimates of market penetration by soy proteins in further-processed poultry items were converted to pounds and number of chickens and turkeys (table 8). Substitutes accounted for less than 0.5 percent of projected 1980 production of young chickens at the highest level of market penetration. Between 3 and 6 percent of mature chickens and 4 percent of turkeys are projected to be replaced by substitutes at the highest level of penetration.

Table 8.--Chickens and turkeys replaced by substitutes, three levels of market penetration by soy protein substitutes, 1980

	Units	Estimated market penetration		
		Low	Medium	High
		Thousands		
Young chicken				
Processed	1,000 lbs.	7,907	15,382	27,830
Liveweight	do.	10,982	21,364	38,653
	No.	3,050	5,843	10,737
Percentage of all young chickens	Pct.	.1	.2	.3
Mature chicken				
Processed	1,000 lbs.	37,200	44,577	61,532
Liveweight	do.	58,125	69,652	96,144
	No.	12,635	15,142	20,901
Percentage of all mature chickens	Pct.	3.2	3.9	5.4
Turkey				
Processed	1,000 lbs.	43,480	60,195	89,214
Liveweight	do.	54,350	75,244	111,518
	No.	2,718	3,762	5,576
Percentage of all turkeys	Pct.	1.7	2.4	3.6

Dairy Products

Cost has been an especially important factor in market penetration by dairy substitutes. Ingredients of most dairy substitutes are less expensive than the natural products replaced. Higher prices of milk fat accounts for the major differences in ingredient costs. Retail prices are also lower for dairy substitutes than for natural dairy products (table 9).

Per capita consumption of butter probably will continue to decline, but at a slower rate since butter's share of the spread market is small. Substitutes are likely to continue to penetrate the market for light and heavy cream. Penetration of the fluid milk market by substitutes will be slow through 1980. At the extreme, 10 percent of the market for fluid milk could be lost to substitutes.

Table 9.--Comparison of average advertised prices and estimated ingredient cost for selected dairy products and substitutes 1/

Product	Package unit	Average advertised retail price	Estimated ingredient cost
		Cents	Cents
Whole milk	1/2 gallon	50.8	29.1
Filled milk	do.	37.4	20.3
Coffee cream	pint	43.3	19.6
Coffee whitener (liquid or frozen)	do.	20.2	5.4
Whipping cream	do.	49.9	29.4
Whipped topping	do.	31.6	4.6
Sour cream	do.	66.8	21.4
Imitation sour cream	do.	45.6	6.9
Ice cream	1/2 gallon	67.2	25.0
Imitation ice cream	do.	41.4	13.3
Ice milk	do.	49.0	14.7
Imitation ice milk	do.	36.2	10.0

1/ Table derived from, "Marketing Margins for Selected Dairy Products and their Substitutes," by Herbert H. Moede, article appearing in Marketing and Transportation Situation, ERS 449, U.S. Dept. Agr., May 1970. Comparisons reflect 1969 prices. Assumptions on which estimates based found in article.

The quantity of milk sufficient for 1980 needs has been projected by ESAD, assuming a level of substitute use consistent with recent trends. This quantity was adopted as the low level of substitute use and an additional medium and high level was assumed. These levels could occur under changes in technology, marketing practices, and regulations that would create more favorable manufacturing and marketing conditions for substitutes and synthetics. The higher level assumes far-reaching changes in the technology of producing fluid milk substitutes along with changes in marketing channels for some substitute products (appendix 12).

Estimates of market replacement by substitutes and synthetics were converted to quantity of milk and number of cows needed to produce the quantity of milk replaced (table 10). The medium estimate of 260,000 cows is a decrease of about 3 percent from the low projection of 8.9 million cows in 1980. At the higher estimate, the herd needed to supply 1980 dairy requirements would be reduced by 831,000 cows or just over 9 percent.

Table 10.--Projected quantity of milk and number of cows replaced by substitutes and synthetics, 1980 1/

Product class	Level of penetration 1/	
	Medium	High
	Million pounds	
Fluid milk and cream	2,062	6,420
Ice cream	361	1,206
Cheese	675	2,252
Canned milk	26	92
Total pounds	3,124	9,970
	1,000	
Number cows 2/	260	831

1/ The projection made by the Economic and Statistical Analysis Division, ERS, gives the quantity of milk required in 1980. This was assumed to reflect the low level of market penetration in so far as replacement of milk by substitutes and synthetics was concerned.

2/ Number of cows calculated by dividing annual production of 444 pounds of butterfat per cow into total butterfat requirements.

Leather

Projecting leather use in 1980 is complicated by known shortcomings in leather substitutes, discontinuance of the production of poromeric materials by some manufacturers, and the expected abundance of cattle hides. Sheet vinyls and cloth-backed vinyls will probably continue as the dominate materials in

low-cost shoes and boots. Leather will continue to remain the dominant material where style, comfort, and durability are important.

Two estimates of penetration of the market for leather by synthetic materials were made for 1980 (table 11). The low projection assumed that 15 percent of all nonrubber shoes would have leather soles and 70 percent leather uppers. The high level assumed that leather soles would be used on only 5 percent of all nonrubber shoes and 50 percent would have leather uppers. Both estimates reflect a decrease from the 1965-69 average of 21 percent of nonrubber shoes with leather soles and 71 percent with leather uppers. Leather used in all other manufacturing was considered a constant for both estimates because of the relatively small amount of leather used in these other items and the difficulty in predicting trends for the individual items.

Table 11.--Projected cow hides replaced, two levels of assumed market penetration by synthetic materials, 1980 1/

Item	Level of penetration by synthetic materials	
	Low	High
	Thousand hides	
Shoes		
Leather soles	1,579	4,210
Leather uppers	348	7,305
Other uses 2/	757	757
Total 3/	2,684	12,272

1/ Projections are in cow hide equivalents, although other hides such as calf and goat are used in uppers.

2/ Different estimates not made for leather in uses other than shoes. Quantity used in each item small and total not expected to be significantly different in two estimates.

3/ Based on present rates of use, about 33 million cow hide equivalents would be needed in 1980.

Wool

Projections of 1980 wool consumption assume the decline in wool use will level off. Part of the recent decline in use appeared to reflect short-term conditions. Also, wool's losses associated with the recent shift to more knitted garments may be arrested since wool is superior in certain ways to the synthetic fibers presently used.

A low and high projection of market penetration by synthetics was made for wool. The low penetration assumes wool for use in carpets would be 0.5 pounds per capita, about the same as the 1968-70 average of 0.47 pounds. Wool for apparel use would be 1.15 pounds per capita, down from the 1968-70 average of 1.59 pounds. The higher level of market penetration assumes per capita consumption would decrease to 0.4 pound for wool in carpet use and 1.0 pound for apparel manufacture. These projected levels of market penetration are converted to pounds of wool replaced by synthetics in 1980 (table 12).

Projected consumption in 1980 of apparel and carpet wool combined would be about 329 million pounds, including domestic mill use plus imports of semiprocessed and manufactured wool textiles. U.S. mill consumption declined from 313 million pounds in 1969 to 248 million in 1970, of which apparel wool was 164 million. Apparel wool mill use was about 1.9 times U.S. domestic production in 1970 and is expected to remain above through 1980.

Table 12.--Projected wool replaced by synthetics, two assumed levels of market penetration, 1980

	Wool replaced 1/	
	Low penetration	High penetration
	Thousand pounds	
Apparel wool	103,400	138,650
Carpet wool 2/	(-7,050)	16,450
Total 3/	96,350	155,100

1/ Wool replaced was calculated by multiplying the difference between the 1968-1970 average per capita consumption and the estimates of 1980 per capita consumption, assuming two levels of market penetration, by estimated 1980 population.

2/ The low estimate projects a small gain in per capita consumption of carpet wool over 1968-70 average.

3/ Based on the 1968-70 per capita average, projected wool consumption in 1980 would be about 484 million pounds.

PROJECTED SUBSTITUTION FOR PLANT PRODUCTS

Cotton

With regard to the cotton industry, it is assumed that the U.S. cotton producer will be able to achieve additional economies in producing and handling cotton. Growers will be more market oriented, producing quantities and qualities required. Price supports will decline as production costs decrease. Cotton will be produced by the more efficient growers in the lowest cost areas. Controls are being developed and will restrict imports to 25 percent or less of total availability. This means that foreign producers will continue to participate in supplying domestic needs. Research and promotion will increase cotton's share of the blend market in broadwoven goods and raise consumption of cotton in knitted fabrics. Availability of textile products for consumption will be 110 square yards per capita, reflecting modest growth in domestic consumption. The 110 square yards also reflect some exported textile products and a small amount of woolen and noncotton textiles.

Cotton mill consumption was projected to 1980 based on four sets of assumptions for textile imports, manmade fiber fabrics as a percentage of total available, and blends as a percentage of manmade fiber fabrics (table 13). Depending on the assumptions, projected cotton consumption in 1980 ranged from about 7.2 to 9.1 million bales. A reasonable set of assumptions placed imports at 25 percent, manmade fiber fabrics at 55 percent of total broadwoven goods available, and blends at 45 percent of manmade fiber fabric production. Under this set of assumptions, cotton use would approximate 9 million bales. An increase in manmade fabrics from 55 to 60 percent, with other assumptions unchanged, would indicate a use of about 8.3 million bales or a decrease of slightly less than 8 percent.

Sweeteners

Per capita consumption of sugar from sugarcane and beets has remained about the same since 1946, although there have been substantial year-to-year fluctuations and an unusual increase since 1968. Per capita consumption since 1955 is shown in figure 4. The decline in per capita consumption beginning in 1962 coincides with increased consumption of both corn and noncaloric sweeteners. It was not until the early 1960's, when sales of mixtures of saccharin and cyclamate became important, that synthetics significantly affected the sugar market. From 1961 to 1965, the total sweetener market expanded, with corn and noncaloric sweeteners growing at a faster rate than sugar. Both corn and noncaloric sweeteners have an additive effect on the total sweetener market, making it difficult to estimate the amount of sugar replaced by other sweeteners. Only 25-33 percent of

Table 13.--U.S. production and imports of cotton and manmade broadwoven textile products and mill consumption of cotton, actual 1964 and 1970, and four alternative projections for 1980

Item	1964	1970	Projections for 1980 1/			
			1	2	3	4
	Billions of square yards					
U.S. production broadwovens	16.175	15.704	20.680	19.338	19.338	19.338
Imports of textile products, equivalent yards	1.524	4.424	5.170	6.462	6.462	6.462
Total availability	17.699	20.128	25.850	25.850	25.850	25.850
U.S. production:						
Manmade fiber broadwovens	4.892	7.085	10.340	10.598	12.924	9.306
Cotton/synthetic blends	.631	2.756	4.136	4.769	6.462	4.188
Imports, manmade fiber textile products, equivalent yards	.328	2.659	3.878	4.912	3.878	4.912
Total manmade textile products availability	5.220	9.744	14.218	15.510	16.802	14.218
	Square yards					
Per capita availability 2/	92.4	98.3	110	110	110	110
	Percent					
Ratio						
Imports/total availability	8.6	21.9	20	25	25	25
Manmades/total availability	29.5	48.4	55	60	65	55
Imported manmades/total availability	1.8	13.2	15	19	15	19
Blends/U.S. manmade fiber broadwoven production	12.9	39.0	40	45	50	45
	Million bales					
U.S. mill consumption of cotton	8.9	8.0	9.1	8.3	7.2	9.0

1/ A 1980 population projection of 235 million was used. Recent trends indicate the population may be about 230 million in 1980 which would decrease domestic requirements. Broadwoven goods were converted to equivalent bales by using 1,397 square yards = 1 bale of cotton. Blended fabrics were assumed to be 50-percent cotton and 50-percent synthetics. A total of 1.05 million bales was assumed used in narrow goods, knitted cloth, and miscellaneous uses.
2/ Per capita availability includes textile goods for export and domestic use.

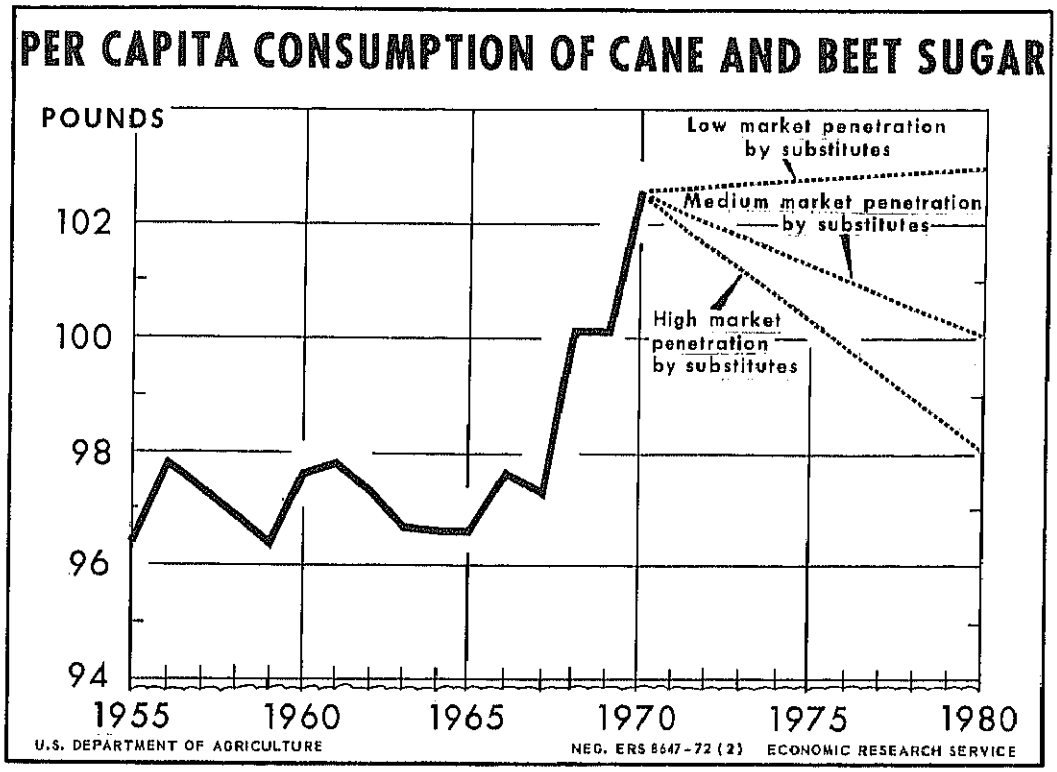

Figure 4

saccharine and cyclamate used in 1964 and 1965 appears to have replaced sugar; the remainder increased the size of the sweetener market 10/.

The relative prices of sweeteners affect the proportions used with sugar. Prices of dextrose and corn sirup have declined somewhat relative to those for sugar since 1957, the decline being much more marked for corn sirup than for dextrose (table 14). The downward trend in the price of corn sirup relative to sugar has been accompanied by a rapid increase in the quantity of corn sirup sold. The increase in sales of dextrose was more moderate, as was the relative decline in the price of dextrose. Most of the increased use of corn sirup has been in the canning, dairy, and baking industries. A University of California study indicates that relative price changes among caloric sweeteners have a significant influence on the quantities used in various industries 11/.

10/ Ballinger, Roy A. Noncaloric Sweeteners: Their Position in the Sweetener Industry. U.S. Dept. Agr., AER-113, May 1967.

11/ Marvin Lee Hayenga. Sweetener Substitution in Food Processing Industries. University Microfilms, Ann Arbor, Mich., 1967.

Table 14.--Prices of dextrose, corn sirup, and refined sugar, 1957-70

Year	Sugar 1/	Dextrose 2/	Corn sirup 2/	Dextrose relative to sugar	Corn sirup relative to sugar
	Cents per pound	Cents per pound	Cents per pound	Percent	Percent
1957	9.15	8.32	9.17	90.9	100.2
1958	9.27	8.33	9.18	89.9	99.0
1959	9.33	8.13	9.10	87.1	97.5
1960	9.43	8.13	9.12	86.2	96.7
1961	9.40	8.10	9.00	86.2	95.7
1962	9.60	8.04	8.73	83.8	90.9
1963	11.94	9.10	9.19	76.2	77.0
1964	10.68	8.85	8.36	82.9	78.3
1965	10.22	8.70	8.27	85.1	80.9
1966	10.36	8.87	8.34	85.6	80.5
1967	10.62	9.10	8.40	85.7	79.1
1968	10.84	9.27	7.85	85.5	72.6
1969	11.44	9.77	7.80	85.4	68.2
1970 3/	11.92	10.15	8.33	85.2	69.9

1/ Refined, wholesale, New York.
2/ Dry basis, wholesale, New York.
3/ First 10 months.

Under the Sugar Quota Act, the Secretary of Agriculture determines the U.S. sugar requirements each calendar year, and then allocates these consumption requirements among domestic and foreign producers, according to the formula in the act. In recent years, about one-half of domestic requirements have been supplied by foreign producers. The administration of the act influences sugar prices to a considerable degree.

Low, medium, and high projections of per capita consumption of sugar were made for 1980 (fig. 4). These consumption projections were made instead of estimates of market penetration because the additive effect of sugar substitutes on the total sweetener market makes it difficult to estimate market penetration. The low projection of per capita consumption assumes that sugar will become even more expensive relative to corn sweeteners and that new noncaloric sweeteners will be developed to fill the void left by banning cyclamate. Under these assumptions of high market penetration by substitutes, per capita consumption of sugar is projected at 98 pounds, representing a total projected consumption

in 1980 of 12.3 million tons, up from the 1970 consumption of 11.2 million tons. The high per capita projection of 103 pounds assumes the current price relationship between sugar and corn sweeteners will be maintained and that saccharin and newly developed noncaloric sweeteners will not capture an additional share of the sugar market. This level of per capita consumption would give a total use of 12.9 million tons.

Citrus Juices

Two projections of citrus beverage consumption, including natural citrus juices plus substitutes and synthetics, were made for 1980. The projection of low market penetration by synthetics and substitutes assumed a 35-percent increase in the per capita consumption of natural citrus juices in 1969-80 and is in line with ERS projections for total citrus products. Per capita changes assumed for other products were: powdered orange synthetic drink up 25 percent, concentrated orange drink and frozen concentrated orange drink 10 percent higher, and frozen concentrated orange synthetic remaining at present levels (table 15). Total per capita consumption of citrus beverages in 1980 under these assumptions would be 3.5 gallons, up 30 percent from 1969. Market shares for natural orange and grapefruit juices would increase slightly under these assumptions, while market shares for all substitute products except powdered orange synthetic drink would decrease slightly. This set of assumptions is based on natural orange products being available in large quantities at reasonable prices. If citrus groves are developed during the next 10 years as in the past 5 years, supplies should meet these expectations.

The higher projection assumes the same per capita consumption of citrus beverages in 1980, 3.5 gallons, but with a slightly higher market penetration by substitutes (table 15).

IMPACT AND IMPLICATIONS

Loss of outlets for animal products through market penetration by synthetics and substitutes would release land and other resources no longer needed to produce livestock and poultry products. However, inputs would be needed to supply raw material for the animal product substitutes. The land and other resources that would not be needed because of the replacement of animal products by substitutes were balanced against the resources needed to produce the substitute products. This yielded an estimate of the net change in resources used. To obtain the expected change resulting from replacement of livestock products by substitutes, feed consumption per animal, yield of feed crops per acre along with raw materials for the animal product substitutes were projected to 1980. Using this approach, acres released from

Table 15.--Projected retail consumption of citrus beverages in 1980

Beverage	Low market penetration by citrus juice substitutes			High market penetration by citrus juice substitutes		
	Per capita consumption	Percentage of market	Total consumption 3/	Per capita consumption	Percentage of market	Total consumption 3/
	Gallons	Percent	Million gallons 4/	Gallons	Percent	Million gallons 4/
Frozen concentrated orange juice	1.944	55.4		1.912	54.5	
Concentrated orange juice	.323	9.2		.317	9.0	
Canned single strength juice	.138	3.9		.135	3.9	
Orange juices	2.405	68.5	565	2.364	67.4	556
Frozen concentrated grapefruit juice	.023	0.7		.023	0.7	
Concentrated grapefruit juice	.342	9.8		.337	9.6	
Grapefruit juices	.365	10.5	86	.360	10.3	85
Concentrated orange drink	.263	7.5		.275	7.8	
Frozen concentrated orange drink	.070	2.0		.074	2.1	
Orange drinks	.333	9.5	78	.349	9.9	82
Frozen concentrated orange synthetic	.092	2.6		.097	2.8	
Powdered orange synthetic	.313	8.9		.338	9.6	
Synthetic orange drinks	.405	11.5	95	.435	12.4	102

1/ Change in per capita consumption from 1969; all natural juice up 35 percent, powdered orange synthetic up 25 percent, concentrated and frozen concentrated orange drink up 10 percent, and frozen concentrated orange synthetic to remain at 1969 level.

2/ Change in per capita consumption from 1969; all natural juices up 33 percent, powdered orange synthetic up 35 percent, concentrated and frozen concentrated orange drink up 15 percent, and frozen concentrated orange synthetic up 5 percent.

3/ Based on projected population of 235 million.

4/ Single-strength basis.

the production of livestock and poultry in 1980 would be greater than the additional acres needed to produce soybeans, the primary ingredient used in manufacturing substitute products.

The greatest impact on release of resources comes from substitution for red meats. Assuming a low level of substitution of basically soy products for processed meat items, approximately 1.6 million acres would be freed, and at the high level almost 3.5 million acres (appendix 13). Not only will the substitution of soy products for meats in manufactured products have a substantial impact on freeing land resources, it will also impinge on prices of livestock and processed meat items. The use of soy proteins as extenders will lower the price of processed meats relative to the carcass price. This, in turn, could decrease the net return to producers of beef animals, as processed meat items are obtained largely from trimmings, culled breeding stock, and meat imports. In all likelihood, soy proteins would replace imported beef first, with domestic supplies affected less. Assuming that the price adjustments in processed meats through larger utilization of soy substitutes were passed on to consumers, the consumption of processed meat items probably would rise.

Under price-support programs, the Government has made substantial purchases of dairy products over the past two decades. Furthermore, the consumption of whole milk has declined as an outgrowth of many factors such as rising prices and dietary concerns. At the same time, the number of milk cows has declined while the output of milk per cow has risen markedly, maintaining a relatively stable level of total milk production. The major ingredients in substitute dairy products are vegetable oil and protein, which are supplied primarily by soybeans. Looking ahead to 1980, it is still expected that oil and protein requirements will come from soya.

Dairy products have been vulnerable to market loss to substitutes in the past partly because of the trend by consumers to use less animal fats and partly because of the prices of milk products. Total land resources released through projected penetration of the market for dairy products is less than from substitutes for red meats. Current projections of milk consumption were assumed to include a low level of market penetration by substitutes, thus there would be no change in land resources from those currently estimated for 1980. At the high level of market penetration, about 900,000 acres of land would become available for other uses (appendixes 14, 15, 16).

The impact of increased use of substitutes could affect the dairy industry more directly than red meat producers. The major cuts of beef appear to be more immune to replacement by substitutes at this time than most dairy products. Fluid milk is less susceptable to market penetration by substitutes than other dairy products, but the market for fluid whole milk is not expanding as it is for red meats and poultry.

The production of poultry requires considerable capital resources. However, the land resources are less than for production of beef and dairy cattle. Thus, the replacement of traditional poultry products by substitution will have a less direct effect on land resources, including that for production of feed grains than is the case for red meats and dairy. Also, the consumption of poultry meats has increased tremendously since the introduction of broilers. Further rises in the consumption of broilers may lessen the impact on producers. The projected replacement of poultry products by substitutes in 1980 resulted in minimal freeing of resources, ranging from the low level of 13,000 acres to the high level of 38,000 acres freed for other uses. In total pounds, poultry consumption is small compared with red meat, and poultry converts feed more efficiently than hogs or cattle (appendixes 17, 18, 19).

Leather is primarily a byproduct of animals slaughtered for food consumption, therefore the penetration of the leather market by synthetics decreases the demand for leather in manufacturing, but does not free land resources. The penetration by synthetics would tend to create a surplus of hides for domestic use as the slaughter of cows and calves in 1980 is projected at approximately 44 million, allowing for a reduction attributable to market penetration by substitutes. The 44 million slaughter figure would be sufficient for domestic production and allow an additional 14 million for export. Slaughter of goats and sheep would further add to the supply of hides for leather.

Domestic sheep are primarily dual purpose, producing both wool and meat. Some Southwest breeds are particularly suited to wool production, but lambs are still produced for meat. Release of land resources caused by reduction in sheep numbers through market penetration by substitutes for mutton used in processed meat was reflected in land released in the red meat category (appendix 13). Declining wool prices of the last few years, due partly to manmade fiber substitutes in the market, further discourage long-term prospects for wool production, and to some extent will affect use of land. But in the past, direct Government payments have protected incomes of domestic wool producers from much of the impact of synthetic fibers, with most of the market loss shifted to suppliers of imported wool. Moreover, the United States may stay a deficit producer of wool. Other factors, besides substitute products, have an important bearing on use of land for raising sheep.

Total net release of land resources through market penetration of synthetics and substitutes in 1980 on red meats, dairy, and poultry products amounts to just over 1.6 million acres at the low level and 5 million acres at the high level of penetration (table 16). This release of acreage reflects the net difference, allowing for the cropland necessary to produce the soybeans used

Table 16.--Projected net change in crop acres, three levels of market penetration by substitutes and synthetics for red meats, dairy and poultry, 1980

	Level of market penetration		
	Low	Medium	High
	Thousand acres 1/		
Soybeans 2/	- 332	- 624	- 989
Cottonseed	+ 99	+ 188	+ 297
Feed grains	+1191	+2079	+3001
Hay	+ 617	+1309	+2363
Silage	+ 69	+ 205	+ 442
Total change	+1644	+3157	+5114

1/ Minus (-) indicates acres required and plus (+) acres released.

2/ Soybean acreage required by substitutes for red meat and poultry as protein, adjusted by excess amount of meal from meeting oil requirements for dairy substitutes. For medium estimate, soybean acreage required was reduced by 225,000 acres and for the high estimate, 718,000 acres.

in the substitute products. However, some of the land released might not be suitable for producing oilseeds or other oil-producing crops.

Substitute products for traditional red meat and poultry items require only the protein part of the soybean, thus the additional acreage needed to produce soy for meat and poultry substitutes would probably add to available supplies of soy oil. Although producing soybeans for protein in the human diet can compound the problem of finding uses for oil in the years ahead, only a minimal upward adjustment over the 43 million acres expected to be harvested in 1971 will be required to meet the needs for substitute products that have been projected for use in human foods.

An influencing factor on the extent of inroads by substitutes and synthetics on agricultural markets are the relative prices of the traditional product and its substitute. Projections to 1980 indicate the price of soybeans will remain near recent levels.

Anticipated economies in processing should hold or at least moderate any upward price movement in the price of soy proteins, resulting in a decrease in the price of soy proteins relative to animal proteins.

Use of more soy proteins in substitutes for red meats, dairy, and poultry products will have a greater impact on the structure of soy processors than producers. Past structural changes have involved fewer and larger crushers and processors, and vertical integration into other areas such as edible oil refining, food and feed manufacturing and exporting. Substitution of soy proteins for meat and dairy products may accelerate integration into production of high-protein foods as larger firms seek new products and market outlets. Stepped up research on methods of fabricating protein foods from soybeans may lead to unforeseen breakthroughs.

Almost 50 percent of textile fabric production is from synthetic fibers or a blend of synthetic and natural fibers. Of all major agricultural products, synthetics have made their biggest inroads on cotton. Pricing and quality consideration account in large part for the penetration made by synthetics on cotton products. Apparently, further penetration will be relatively small in comparison to that experienced in the past decades. Some increase is expected in total cotton production by 1980, but with the exception of concentration of cotton in areas where it can be grown most economically, additional acreage devoted to the crop will not likely be of any sizeable magnitude because of the expected increase in yields per acre. Changes in cotton exports could cause a change in the quantity of resources used in cotton production. Changing styles in clothing, shifting age composition of the population, and technological advancements in textile manufacturing will require varietal and quality adjustments.

The greatest impact from use of synthetic sweeteners would be on cane and beet sugar, because they comprise about 82 percent of the noncaloric sweetener market, whereas corn sweeteners constitute only about 17 percent. There are more market outlets for corn products than for beets and sugarcane. Thus, corn sugar and corn sirup experienced a steady increase in per capita consumption into the 1960's when synthetics made their greatest inroads in the beet and sugarcane market. Even with the highest level of market penetration by synthetic sweeteners, the total quantity of sugar required is expected to increase about 9 percent from 1970 to 1980. At the low level, the increase would be about 15 percent. The likely increase in yields per acre of sugarbeets and cane combined with ample supplies of imports indicate resources utilized in the production of sugarcane and beets will remain about the same. Imports of sugar have ranged between 40 and 45 percent of total consumption, making adjustment in domestic sugar production very minimal if the present quota system is maintained through 1980.

Consumption of natural citrus beverages is expected to increase 33-35 percent by 1980. The lower percentage increase in consumption reflects higher market penetration by synthetic citrus drinks. These projections point to use of additional land and other resources to supply the expected increase in consumption of citrus beverages. The assumption of only slight gains in market shares by synthetics by 1980 was predicated on ample supplies of citrus, assuring competitive prices with synthetics. Historically, synthetics have made their greatest inroads on citrus consumption after severe freezes when quality of products were low and prices high. The impact of synthetics might be minimized by management of available stocks of citrus in times of curtailed production.

The number of acres freed at the high level use of substitutes and synthetics would be about 1½ percent of the land presently used for crops. Although this is a relatively small percent of total cropland, it does represent freed acres that could be shifted to other uses. It is also likely that this land would be available for longer time periods than land held in reserve to be shifted in and out of production. Land freed through increased use of substitutes could be used for recreation and leisure time activities. Reduction in animals and crop needs because of increased use of substitutes and synthetics also implies some reduction in the need for tractors, fertilizer, medication, and other inputs used in agricultural production. In general, changes resulting from increased use of substitutes are small but reinforce the trend toward a reduced farm population and a decrease in land and other resources needed to supply food and fiber needs.

There could be an increase in the welfare of consumers with increased use of substitutes and synthetics. In some cases, substitutes and synthetics have a moderating influence on prices, and in other cases may provide a product with more stabilized qualities. However, manufacturers will have to give more information on quality and handling instructions for synthetic fabrics. Food processors will need to direct their advertising more toward preparing, serving, and nutritional labeling for substitute foods. As more fabricated foods are used, regulatory agencies will need to increase their capabilities to ensure that quality and nutritional standards are met.

In conclusion, synthetics do not appear to present major adjustment problems for agricultural resources in the decade of the seventies. However, the analysis did not consider such factors as changes in demand, geographic shifts, changes in land use, and size of production units. If such factors were included different conclusions might be obtained.

GLOSSARY

Amino acids--Chief components and determinants of the characteristics of a protein. They are the building blocks of living tissues. Eighteen different amino acids commonly occur in our food supply and eight are considered essential because the body cannot make them from any materials.

Meat analogs--Material usually prepared from vegetable protein to resemble specific meats in texture, color, and flavor.

Defatted soy flakes--Formed when soybeans are cleaned, dehulled, flaked, oil extracted, heated, and cooled. Protein content ranges from 52 to 55 percent.

Meat extenders--Use of soy or other vegetable proteins as partial substitutes for meat in processed items such as patties, chili, casseroles, etc.

Isolated soy protein--Produced by extracting a white flake or flour with water or a mild alkali. Isolate generally has a protein content of 90 percent.

Manmade fiber fabrics--Fabrics made from synthetic fibers, or from a blend or mixture with and natural fibers where the synthetic portion comprises more than 50 percent by weight or value.

Polyester--A noncellulosic synthetic fiber.

Poromerics--Family of plastic materials containing microscopic holes that allow for the passage of air and moisture. One use is as a substitute for leather.

Soy flour and grits--Produced from grinding defatted soy flakes; grits are coarser ground than flour.

Soy protein concentrate--Produced from defatted soybean flakes or flour by a process which immobilizes the protein and removes the soluble sugars, minerals, etc. Concentrate has a protein content of 70 percent.

Substitutes--Agricultural raw materials or products that replace other agricultural products in traditional uses.

Synthesized, fabricated, engineered--Terms applied to the process of producing a food product from a number of elements. The purpose may be to duplicate an existing food in texture, color, nutrition, and flavor; or to produce a product to certain standards that may not presently exist in other foods.

Synthetics--Products derived principally from nonagricultural sources or from agricultural sources processed so their origin is not easily identified.

Textured vegetable protein--Soy or other vegetable protein that has texture imparted either by spinning a fiber and combining the fiber in layers to achieve the desired texture or by a thermoplastic extrusion process.

Appendix 1.--Per capita consumption of citrus beverages, 1960-70

Beverage	Per capita consumption 1/										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
	Gallons										
Orange juices:											
Frozen concentrated	1.431	1.395	1.629	0.932	0.915	1.287	1.295	1.576	1.512	1.440	1.657
Concentrated	.138	.154	.173	.151	.152	.180	.223	.257	.242	.239	.265
Canned single strength	.184	.131	.150	.121	.078	.094	.118	.132	.114	.102	.111
Grapefruit juices:											
Frozen concentrated	--	--	--	--	--	--	--	--	2/.006	.017	.020
Concentrated	.134	.163	.166	.137	.162	.157	.167	.223	.190	.254	.226
Orange drinks: 3/											
Concentrated	--	--	--	--	4/.035	.189	.208	.231	.236	.239	.198
Frozen concentrated	--	--	--	.140	.143	.075	.044	.025	.033	.064	.054
Synthetic orange drinks:											
Frozen concentrated	--	--	--	--	5/.061	.117	.104	.083	.099	.092	.256
Powdered	--	--	--	--	4/.035	.143	.134	.162	.192	.250	.256

1/ Computed on single-strength basis.
2/ Does not include first 6 months.
3/ Does not include canned orange drinks.
4/ Does not include first 9 months.
5/ Does not include first 3 months.

Based on data from: Department of Citrus, Citrus Digest, Market Research Department, Lakeland, Fla., January 1960--December 1969 and U.S. Department of Commerce, Survey of Current Business, Washington, 1961-1970.

Appendix 2.--Distribution of total retail citrus beverage market among nine products, 1960-70

Beverage	Share of market 1/										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
	Percent										
Orange juices:											
Frozen concentrated	75.9	75.7	76.9	62.9	60.3	57.4	56.5	58.6	57.6	53.4	58.0
Concentrated	7.3	8.3	8.2	10.2	10.0	8.0	9.7	9.6	9.2	8.9	9.3
Canned single strength	9.7	7.2	7.1	8.2	5.1	4.2	5.1	4.9	4.3	3.8	3.9
Grapefruit juices:											
Frozen concentrated	--	--	--	--	--	--	--	--	0.2	0.6	0.7
Concentrated	7.1	8.8	7.8	9.2	6.5	7.0	7.3	8.3	7.3	9.4	7.9
Orange drinks: 2/											
Concentrated	--	--	--	--	2.3	8.4	9.1	8.6	9.0	8.8	6.9
Frozen concentrated	--	--	--	9.5	9.4	3.4	1.9	0.9	1.3	2.4	1.9
Synthetic orange drinks:											
Frozen concentrated	--	--	--	--	4.0	5.2	4.5	3.1	3.8	3.4	2.4
Powdered	--	--	--	--	2.4	6.4	5.9	6.0	7.3	9.3	9.0
Total citrus beverages	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ Percentages computed on basis of single-strength gallons purchased per year.
2/ Does not include canned orange drinks.

Source: Department of Citrus, Citrus Digest, Market Research Department, Lakeland, Fla., January 1960-December 1970.

Appendix 3.--Average retail price for selected citrus beverages, 1960-69

Beverage	Unit size	Annual average price									
		1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
		Cents									
Orange juices:											
Frozen concentrated	(6 oz.)	18.3	20.6	16.7	26.3	26.0	18.8	18.4	14.4	18.2	20.3
Concentrated	(32 oz.)	38.5	40.4	36.8	45.5	47.6	42.6	40.1	33.9	38.9	41.4
Canned single strength	(46 oz.)	36.8	42.7	36.9	46.7	57.0	45.3	39.3	34.4	40.2	43.1
Grapefruit juices:											
Frozen concentrated	(6 oz.)	--	--	--	--	--	--	--	--	1/21.7	23.2
Concentrated	(46 oz.)	31.3	29.0	28.1	36.3	43.1	37.3	38.8	33.5	39.7	37.7
Orange drinks:											
Concentrated	(64 oz.)	--	--	--	--	2/57.6	54.0	52.2	49.8	48.9	49.7
Frozen concentrated	(6 oz.)	--	--	--	16.8	16.5	14.6	12.7	11.5	12.1	19.6
Synthetic orange drinks:											
Frozen concentrated	(9 oz.)	--	--	--	--	3/36.6	35.9	32.6	32.4	32.9	35.3
Powdered	(18 oz.)	--	--	--	--	2/87.9	88.7	90.2	86.9	86.6	88.5

1/ Does not include the first 6 months.
2/ Does not include the first 9 months.
3/ Does not include the first 3 months.

Source: Department of Citrus, Citrus Digest, Market Research Department, Lakeland, Fla., January 1960-December 1969.

Appendix 4.--U.S. production of fine cotton fabrics, 1960-70

Fabric	1960	1964	1965	1966	1967	1968	1969	1970 1/
Combed and fine carded:	Millions of linear yards							
Broadcloth	291	212	--	119	93	41	40	30
Lawns and organdies	216	134	161	153	96	85	70	32
Oxfords	54	69	47	95	51	33	10	6
Poplins	27	20	32	52	36	40	40	6
Sateens	102	46	25	22	39	21	10	12
Sheeting	192	268	286	269	274	224	117	126
Twills and seersucker	52	88	62	52	46	22	19	17
Gingham	199	185	185	99	46	21	3/--	3/--
Colored yard shirt and dress goods	112	134	130	109	86	81	36	33
Fine carded	--	116	116	88	95	77	64	52
Other 2/	230	208	201	182	176	186	193	173
Total	1,475	1,480	1,245	1,240	1,038	831	599	487

1/ Annual rate based on data for January-June 1970.
2/ Bedspreads, drapery, upholstery, velvet, and damask.
3/ Only one manufacturer - data not divulged.

Source: Bureau of Census, U.S. Department of Commerce.

Appendix 5.--U.S. production of cotton blended with polyester, by fabric, 1964-70

Fabric	1964	1965	1966	1967	1968	1969	1970
	Millions of linear yards						
Batiste	86	117	158	175	308	280	295
Sheeting	--	--	20	48	138	243	323
Broadcloth	95	129	175	151	233	301	396
Corduroy	--	--	23	19	24	1/--	1/--
Gabardine	--	--	47	59	74	52	67
Other twills	--	--	--	--	170	198	153
Oxfords	12	24	82	134	126	124	63
Poplins	104	135	148	144	195	152	143
Sateens	--	--	--	--	6	7	4
Voiles	--	11	35	25	84	87	45
Yarn dyed fabrics	--	--	165	163	220	237	219
Piece dyed fabrics	--	--	--	--	68	42	--
Others	128	267	196	252	107	161	193
Total	425	683	1,049	1,170	1,753	1,884	1,963

1/ Less than 5 million yards indicated.

Source: Bureau of Census, U.S. Department of Commerce.

Appendix 6.--U.S. production of coarse and medium count cotton broadwoven fabrics, 1960-70

Fabric	1960	1964	1965	1966	1967	1968	1969	1970 1/
	Millions of linear yards							
Duck and allied fabrics	206	234	248	285	278	271	271	226
Osnaburg	185	184	232	310	360	236	217	191
Carded sheeting	1,379	1,276	1,344	1,299	1,242	1,169	1,062	990
Carded poplins	82	100	90	128	121	114	80	73
Drills	199	228	247	230	215	181	178	169
Twills	450	480	648	473	418	324	245	224
Jeans	53	54	60	48	42	37	42	30
Corduroy	138	166	156	135	191	140	130	163
Denim	257	271	258	296	264	215	224	269
Sateen	148	99	95	110	109	81	86	96
Diaper cloth	80	82	84	87	86	85	87	85
Plain print cloth	1,589	1,229	1,204	1,053	954	910	891	783
Tobacco and cheese cloth	886	961	1,085	1,141	1,174	1,160	1,251	1,193
Carded broadcloth	492	377	389	362	292	246	216	144
Bed ticking	71	61	68	61	61	58	2/--	2/--
Towels, dish cloths, etc.	548	658	713	656	624	620	590	577
Blanketing	202	165	176	154	152	143	140	135
Total	6,965	6,625	7,097	6,828	6,583	5,990	5,710	5,348

1/ Annual rate based on data for January-June 1970.
2/ Only one manufacturer not published.

Source: Bureau of Census, U.S. Department of Commerce.

Appendix 7.--Projected production of processed meat, prepared food products, and canned items, 1980

Item	Estimated production in 1980
Processed or prepared items:	--------Million lbs.--------
Cooked beef	113
Cooked pork	184
Other cooked meats	36
Fresh finished sausage	623
Sausage to be dried	257
Franks, weiners	1,399
Bologna	712
Other sausage, smoked or cooked	783
Loaf, head cheese, chili, jellied products	359
Hamburger, including ground beef	5,194
Bacon	1,878
Other sliced meats	924
Miscellaneous meat product	535
Frozen foods-dinners, meat pies, etc.	942
Canned meats:	
Plain meat	1,019
Italian dishes	433
Mexican dishes	352
Stews and hash	355
Soup	894
All other with 20% or more meat or meat byproducts	274
All other with less than 20%	514

Appendix 8.--Assumed levels of market penetration by soy protein in selected processed meat items, 1980 1/

Item	Soy protein used		
	Low level	Medium level	High level
	Percent		
Processed meat or prepared food items:			
Cooked beef	0	0	0
Cooked pork	0	0	0
Other cooked meats	0	0	0
Fresh finished sausage	4	6	8
Sausage to be dried	3	6	8
Franks, weiners	4	6	8
Bologna	5	7	8
Other, smoked, or cooked sausage	5	7	8
Loaf, head cheese, chile, jellied products	3/	1	1
Hamburger, including ground beef	4	7	9
Bacon 2/	3/	1	1
Other sliced meats	3	5	7
Miscellaneous meat product	3	6	7
Frozen foods-dinners, meat pies, etc. (estimated to average 20% meat)	3/	3/	3/
Canned meats:			
Plain meats	0	0	0
Italian dishes (15% meat)	1	1	1
Mexican dishes (estimated to average 20% meat)	1	1	2
Stews and hash (estimated to average 30% meat)	1	2	2
Soup 3/	-	-	-
All other with 20% or more meat and/or meat by-products (estimated to average 30% meat)	1	2	2
All other with less than 20%	3/	1	1

1/ Unless otherwise noted, soy protein was dry concentrate containing 70-percent protein.
2/ Soy protein for bacon was the spun product.
3/ Less than 0.5 percent.

Appendix 9.--Poultry slaughtered and used in further processing, 1960, 1965, 1970, and projected to 1980 1/

	1960	1965	1970	1980
	Million pounds			
	Young chickens			
Total 2/	3,699	5,194	7,161	9,884
Further-processed	102	139	337	593
Percentage of total	2.8	2.7	4.7	6.0
	Mature chickens			
Total 2/	372	425	516	744
Further-processed	192	310	392	684
Percentage of total	51.6	72.9	76.0	92.0
	All turkeys			
Total 2/	948	1,330	1,561	2,174
Further-processed	102	253	479	978
Percentage of total	10.8	19.0	30.6	45.0

1/ Source: Issues of "Poultry Slaughtered Under Federal Inspection and Poultry Used in Canning and Other Processed Food," USDA, SRS.

2/ Total certified ready-to-cook weight.

Appendix 10.--Projected use of poultry meat in further-processed products by end product and market class, 1980

Item	Young chickens		Mature chickens		Turkeys	
	Pct.	1,000 lbs.	Pct. 1/	1,000 lbs.	Pct. 1/	1,000 lbs.
Meat parts, giblets, fat (in bulk)	5.0	29,650	24.4	167,238	17.2	168,216
Rolls, roasts, breasts	7.7	45,661	2/	--	39.1	382,398
Soup, broth, bullion, consomme, soup base	0.2	1,186	22.4	153,558	3.1	30,318
Pot pies	0.5	2,965	14.3	97,812	11.5	112,470
Canned boned meat	4.1	24,313	15.7	107,388	3.0	29,340
Cooked chicken parts and whole birds	41.3	244,909	0.2	1,368	--	--
Turkey dinners	--	--	--	--	18.9	184,842
Fried chicken dinner	30.6	181,458	--	--	--	--
Canned whole birds	--	--	10.8	73,872	--	--
Sliced and prepared meats	2.3	13,639	0.8	5,472	4.7	45,966
Baby foods	0.6	3,558	2.0	13,680	1.0	9,780
Gourmet and spcialty	4.0	23,720	0.6	4,104	0.4	3,912
Steaks, patties, fillets, croquettes, sticks	2.6	15,418	0.5	3,420	0.9	8,802
Foreign food preparations	0.4	2,372	1.6	10,944	2/	2/
Freeze-dried	0.1	593	1.7	11,628	2/	2/
With noodles, a la king, fricassee	0.1	593	1.1	7,524	0.2	1,956
Salad	2/	--	0.9	6,156	--	--
Hash, stew with dumplings	0.5	2,965	2.9	19,836	--	--
Total	100.0	593,000	100.0	684,000	100.0	978,000

1/ Taken from Rogers, George B. and Smith, Harold D., Further Processing and Impact of Economies of Scale in Poultry Plants, Agr. Exp. Sta., Univ. of Md., Misc. Pub. 595.
2/ Less than [illegible] percent.

Appendix 11.--Assumed levels of market penetration by substitutes for further processed poultry items, 1980

Item	Level of market penetration								
	Young chicken			Mature chicken			Turkeys		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
	Percent								
Meat parts, giblets, fat (in bulk)	1	2	3	5	7	10	5	7	10
Rolls, roasts, breasts	3	5	8	–	–	–	5	7	10
Soup, broth, bullion consomme, soup base	4	7	10	5	7	10	4	6	8
Pot pies	2	5	8	5	7	10	5	7	10
Canned boned meat	2	3	6	5	6	8	4	6	8
Cooked chicken parts and whole birds	1	2	4	1	1	2	–	–	–
Turkey dinners	–	–	–	–	–	–	2	3	6
Fried chicken dinners	1	2	4	–	–	–	–	–	–
Canned whole birds	–	2	4	6	7	8	–	–	–
Sliced and prepared meats	4	8	10	4	6	8	6	8	12
Baby foods	2	3	5	1	1	2	1	1	2
Gourmet and specialty	2	3	5	1	1	2	1	1	2
Steaks, patties, fillets, croquettes, sticks	2	5	8	6	8	12	6	8	12
Foreign food preparations	1	3	5	5	7	10	–	–	–
With noodles, a la king, fricasses	2	5	10	5	7	10	3	7	10
Salad	–	–	–	2	3	5	–	–	–
Hash, stew, dumplings	4	8	12	5	7	9	–	–	–

Appendix 12.--Assumed levels of market penetration by dairy substitutes, 1980

Dairy product	Level of penetration	
	Medium	High
	Percent	
Fluid whole milk	3	10
Cream	10	25
Low-fat milk	3	10
American cheese	3	10
Other cheese	3	10
Evap. whole milk	2	7
Cond. whole milk	2	7
Ice cream	3	10
Ice milk	3	10

Appendix 13.--Projected net change on crop acreage, three assumed levels of market penetration by soy protein substitutes for processed meat, 1980

Crop	Low-level soy substitution			Medium-level soy substitution			High-level soy substitution		
	Acres needed	Acres released	Net change	Acres needed	Acres released	Net change	Acres needed	Acres released	Net change
	1,000 acres								
Soybeans	555	231	- 324	901	375	- 526	1,176	490	- 686
Cottonseed		99	+ 99		161	+ 161		211	+ 211
Feed grain		1,170	+1,170		1,900	+1,900		2,480	+2,480
Hay		617	+ 617		1,001	+1,001		1,307	+1,307
Silage		69	+ 69		112	+ 112		146	+ 146
Total			+1,631			+2,648			+3,458

Appendix 14.--Projected oil and protein requirements and pounds of soybeans needed to supply these requirements, two assumed levels of market penetration by dairy substitutes, 1980

	Medium estimate	High estimate
	1,000 lbs.	
Required	115,588	368,891
Required protein	73,624	234,964
Pounds required to supply oil	631,628	2,015,797
Oil supplied	115,588	368,891
Meal supplied	496,460	1,584,416
Protein supplied	218,442	697,143
Surplus protein	144,818	462,180
Meal needed	167,327	534,008
Surplus meal	329,133	1,050,408

1/ A yield of 18.3 percent oil and 78.6 percent meal was used in these calculations.

Appendix 15.--Projected feed and acreage released, two assumed levels of market penetration by diary substitutes, 1980

Type feed 1/	Tons per cow	Tons released 1980		Estimated yield 1980: (tons) 4/	Acres released	
		Med. est. 2/	High est. 3/		Med. est.	High est.
Feed grains...	1.3733	357,515	1,140,982	2.40	148,964	475,410
Soybeans.....	.0795	20,695	66,051	.93	22,253	71,022
Cottonseed....	.0495	12,886	41,126	.48	26,846	85,679
Hay.....	2.9226	760,849	2,428,192	2.30	308,139	1,055,736
Silage.....	4.9173	1,280,135	4,085,455	13.80	92,763	296,048

1/ Tons of feed and number of cattle taken from National and State Livestock-Feed Relationship, Sta. Bul. 446, U.S. Dept. Agr.
2/ Tons per cow times (260,333) reduction herd in 1980, medium estimate.
3/ Tons per cow times (830,833) reduction herd in 1980, high estimate.
4/ Derived from estimates made in Economic and Statistical Analysis Division, ERS, USDA. Silage estimated by applying an index at expected gain at all crops to present yields of silage. Cotton seed derived from a projected yield of lint.

Appendix 16.--Projected net change on crop acreage, two assumed levels of market penetration, by substitute dairy products, 1980

Crop	Medium penetration			High penetration		
	Required	Released	Net change	Required	Released	Net change
	1,000 acres					
Soybeans	339	22	-317	1,084	71	-1,013
Cottonseed	--	27	+ 27	--	86	+ 86
Feed grains	--	149	+149	--	475	+ 475
Hay	--	308	+308	--	1,056	+1,056
Silage	--	93	+ 93	--	296	+ 296
Total net change	--	--	+260	--	--	+ 900

Appendix 17.--Projected soy protein requirements and acreage needed to supply these requirements, three assumed levels of market penetration by poultry substitutes, 1980

	Units	Levels of market penetration		
		Low	Medium	High
		--------Thousands---------		
Young chicken				
Chicken replaced	Pounds	7,907	15,382	27,830
Soybean replacing chicken 1/				
Concentrate	do.	1,318	2,564	4,638
Isolate	do.	988	1,923	3,479
Mature chicken				
Chicken replaced	do.	37,200	44,577	61,532
Soybean replacing chicken				
Concentrate 2/	do.	12,400	14,859	20,511
Turkey				
Turkey replaced	do.	43,480	60,195	89,214
Soybean replacing turkey 3/				
Concentrate	do.	7,247	10,032	14,869
Isolate	do.	5,435	7,524	11,152
All poultry				
Concentrate	do.	20,965	27,455	40,018
Isolate	do.	6,425	9,447	14,631
Concentrate 4/	Bushels	806	1,056	1,539
Acres required	Acres	26	34	50
Isolate 5/	Bushels	450	662	1,025
Acres required	Acres	15	21	33
Total soybean required to replace chicken and turkey, 1980	do.	41	55	83

1/ Assumes one-half vegetable protein will be concentrate and one half isolate. One pound of concentrate will replace 3 pounds of meat and 1 pound of isolate will replace 4 pounds of meat.
2/ Assumes concentrate can be used to replace mature chicken.
3/ Assumes one half vegetable protein will be concentrate and one half isolate.
4/ Calculated assuming a yield of 26 pounds of concentrate (70% protein) per bushel.
5/ Calculated assuming a yield of 14.28 pounds of isolate (90% protein) per bushel.

Appendix 18.--Projected soybean and corn acreages released, three assumed levels of market penetration by substitutes for chicken and turkey meat, 1980

	Units	Levels of market penetration		
		Low	Medium	High
Young chicken		Thousands		
Processed replaced	Pounds	7,907	15,382	27,830
Liveweight replaced 1/	do.	10,982	21,364	38,653
Total feed released 2/	do.	21,964	42,728	77,306
Yellow corn 3/	do.	14,057	27,346	49,476
Soybean meal (49% protein) 4/	do.	5,491	10,682	19,326
Soybeans 5/	Bushels	125	243	439
Corn 6/	do.	251	488	883
Soybean 7/	Acres	4	8	14
Corn 8/	do.	2	4	8
Turkeys				
Processed replaced	Pounds	43,480	60,195	89,214
Liveweight replaced 9/	do.	54,350	75,244	111,518
Total feed released 10/	do.	163,050	225,731	334,552
Yellow corn 11/	do.	114,135	158,012	234,166
Soybean meal (44% protein) 12/	do.	44,024	60,947	90,329
Soybeans 13/	Bushels	917	1,270	1,882
Corn 6/	do.	2,038	2,822	4,182
Soybean 7/	Acres	30	41	61
Corn 8/	do.	19	26	38
Total released 14/				
Soybeans	do.	33	49	75
Corn	do.	21	30	46

1/ Based on dressed yield of 72 percent.
2/ Based on 1980 feed conversion of 1 pound of gain per 2 pounds of feed.
3/ Based on ration 64 percent corn. Could be equivalent grain.
4/ Based on ration 25 percent soybean meal (49 percent protein).
5/ Yield of 44 pounds of 49 percent meal per bushel.
6/ 56 pounds of corn per bushel.
7/ 1980 projected yield of 31 bushels per acre.
8/ 1980 projected yield of 106 bushels per acre.
9/ Yield of 80 percent dressed from liveweight.
10/ Feed conversion of 3 pound feed to 1 pound gain.
11/ Based on 70 percent of corn.
12/ Based 27 percent soybean meal.
13/ Yield of 48 pounds of meal.
14/ Mature chickens are a byproduct of egg product - no acres released by their replacement.

Appendix 19.--Projected net change on corn and soybean acreage, three assumed levels of market penetration by substitute poultry products, 1980

Crop	Level of penetration								
	Low			Medium			High		
	Required	Released	Net change	Required	Released	Net change	Required	Released	Net change
	1,000 acres								
Soybeans	41	33	- 8	55	49	- 6	83	75	- 8
Corn	--	21	+21	--	30	+30	--	46	+46
Total net change	--	--	+13	--	--	+24	--	--	+38